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MINES AND QUARRIES

1902

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LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF THE CENSUS,
Washington, D. C., July 7, 1904.

SIR:

I have the honor to transmit herewith a report on mines and quarries and petroleum and natural-gas wells for the year ending December 31, 1902. This report contains the statistics of the Twelfth Census of the mining industries of the United States. At all prior censuses the mining industries have been enumerated at the same time as the population, manufactures, and agriculture, but the date of the enumeration was changed by the act of Congress of March 6, 1902, which provides that the statistics relating to mines, mining, quarries, and minerals, should be collected decennially after the completion and return of the enumeration and of the work upon the schedules relating to the products of agriculture and to manufacturing and mechanical establishments.

The mining census was conducted in collaboration with the United States Geological Survey, the statistics being collected in connection with the data required for the annual report of the mineral resources of the United States. The objects of this collaboration were to avoid duplication of the fieldwork and the necessity of calling on the mine operators for duplicate reports; also to obtain harmonious results for the two offices. The totals for the two offices agree, with the exception of a few minerals, for which the Geological Survey includes manufacturing processes carried on entirely distinct from the mining operations, and in some instances where that office calls for the product marketed or sold instead of that produced during the year.

Mining industries are frequently carried on by establishments engaged in both mining and manufacturing, and for statistical purposes it is often impossible to separate the operations. The report on manufactures for the Twelfth Census includes the statistics for all products that could be considered as the results of manufacturing processes, and such products have, as far as possible, been excluded from this report. It would add to the value of these statistics if the mining and manufacturing industries were covered by the same enumeration and the total presented as the manufacturing and mechanical industries of the country. Under the existing law it is impossible to compile such a total for the same year for all branches of industry.

This report has been prepared in the division of manufactures, under the supervision of Mr. William M. Steuart, chief statistician for manufactures, assisted by Mr. Joseph D. Lewis, chief of division. I desire also to acknowledge the services of the efficient force of the Geological Survey that worked under the supervision of Dr. David T. Day, chief of the division of mining and mineral resources, and of Mr. William A. Countryman, of this Bureau, who assisted in the preparation of the textual discussion.

Very respectfully,

S. N. D. North
Director.

HON. VICTOR H. METCALF,
Secretary of Commerce and Labor.

MINES AND QUARRIES.

CHAPTER I.

PLAN AND SCOPE OF INQUIRY.

I.

PROVISIONS OF LAW.

The First Census of the United States, taken in 1790 by the United States marshals and their assistants, contained no statistics relative to manufacturing or mining industries, being confined to an enumeration of the inhabitants or population of the country. The Second Census, taken in 1800, was practically the same in scope. The first attempt to collect any industrial statistics was made in connection with the Third Census, under the provisions of a special amendatory act, passed May 1, 1810, which required the "marshals' secretaries and their assistants * * * to take * * * an account of * * * manufacturing establishments and manufactures." From the digest of these statistics, prepared by Tench Coxe under the direction of the Secretary of the Treasury, it appears that the schedule secured information concerning the cutting and dressing of marble, slate, and other stones, the quarrying of slate, the mining of saltpeter, and the production of red and yellow ocher, but that no reference was made to minerals from which metallic substances are derived save in the classification "lead and manufactures of lead." There was included under this classification the substance known as black lead (graphite). Although the law providing for the census of 1820 contained a provision similar to that of the law of 1810 concerning industrial statistics, there is no evidence that statistics of mines and quarries were taken. The section concerning industrial statistics was omitted from the law providing for the census of 1830.

No further attempt appears to have been made to collect statistics for mines and quarries until the census of 1840, which was taken in conformity with the act of March 3, 1839. This was the first census law to contain a specific provision for the collection of statistics of mines. Section 13 of the law provided that "the aforesaid marshals and their assistants * * * also shall collect and return in statistical tables under proper heads, according to such forms as shall be furnished, all such information relating to mines, agriculture, commerce, manufactures, and schools as will exhibit a full view of the pursuits, industry, education, and resources of the country * * *."

The Seventh, Eighth, and Ninth censuses were taken under the act of May 23, 1850, which authorized not only the enumeration of all inhabitants, but also the collection of "all the other statistical information * * * specified in the instructions which shall be given by the Secretary of the Interior and in the tables annexed." Under this provision statistics of mines continued to be taken, but only in a scattering way and in connection with other statistics until the census of 1870, when they were given separately and with comparative fullness.

Section 18 of the act of March 3, 1879, providing for the census of 1880, contains the following provision: "And said Superintendent may employ experts and special agents to investigate in their economic relations the manufacturing, railroad, fishing, mining, and other industries of the country * * *." The form of the inquiries concerning mining and other productive industries was left to the discretion of the Superintendent of the Census and the Secretary of the Interior.

The only direct reference to a mining census that is made in the act of March 1, 1889, which provided for the Eleventh Census is contained in section 17. This section provided that the only volumes to be published in connection with that census were those relating to population and social statistics, manufactures, mining, agriculture, mortality and vital statistics, valuation and public indebtedness, recorded indebtedness, and statistics relating to railroad corporations and incorporated express, telegraph, and insurance companies. But among the reports which the Superintendent was "required to obtain," if directed to do so by the Secretary of the Interior, were those "from all corporations or establishments reporting products other than agricultural products."

The act of March 3, 1899, providing for the Twelfth Census, was the first census law to describe the scope of the mining census and to make a definite line of demarcation between the statistics of mines and those of manufactures. Section 8 provides "that after the completion and return of the enumeration and of the work upon the schedules relating to the products of agriculture and to manufacturing * * * the Director of the Census is hereby authorized to collect statistics relating to * * * mines, mining, and minerals, and the production and value thereof, including gold in divisions of placer and vein, and silver mines, and the number of men employed, the average daily wage, average working time, and aggregate earnings in the various branches and aforesaid divisions of the mining industry * * *." Before the reports on population, agriculture, and manufactures were completed the act of March 6, 1902, providing for the establishment of a permanent Census Office, became a law, and it was therefore in conformity with this law rather than that of March 3, 1899, that the census of mines and quarries of 1902 was taken. No material change was made, however, in the provisions of section 8, cited above.

At all censuses prior to the Twelfth the statistics of mines and quarries, whenever taken, were collected in connection with the statistics of population, agriculture, and manufactures, and were published as a part of the regular census reports. This practice is correct from both a theoretical and a practical point of view. The separation for the census of 1900 was made apparently because the work incident to the mining census might have tended to delay the completion of the reports on the other more important subjects. It is a distinct advantage, however, to have the reports on agriculture, manufactures, and mining cover the same, or practically the same, period, as it is thus made possible to present statistics of all branches of productive industry for the same year. Under the present law and practise the year covered by the mining census does not expire until more than two and one-half years after the close of that covered by the other industrial statistics—one being the calendar year, and the other the year ending June 1—therefore the reports for the mining census can not be published until about four years after the census year covered by the statistics of manufactures and agriculture. The period covered by the present mining census is the year ending December 31, 1902, and the conditions prevailing during that year in some branches of mining differed materially from those that prevailed during the census year ending June 1, 1900. This difference is especially noticeable in the anthracite coal industry, where the mining operations were practically suspended for six months, although they were in full operation during the entire year covered by the census of 1900. Still, in order to show totals for the mechanical, manufacturing, and mining industries, the statistics for these two dissimilar years must be combined, though the totals are a combination of statistics that represent a prosperous condition for manufactures and a depressed condition in one important branch of mining. The combination, therefore, is not indicative of the results of a year's work under either condition. The office was cognizant of these objections to a mining census covering the year 1902 and the advisability of such a census was carefully canvassed. After much consideration Mr. S. N. D. North, who then held the position of chief statistician for manufactures, sent the following letter of recommendation to the Director of the Census:

> OCTOBER 11, 1902.
>
> HON. WILLIAM R. MERRIAM,
> *Director of the Census.*
>
> DEAR SIR: In accordance with your verbal instructions I have consulted with a number of people, including Colonel Wright, Commissioner of Labor, and Mr. Walcott, Director of the Geological Survey, in regard to the advisability of making a census of the mining industry as of the year 1902, in view of the fact that the coal strike in the anthracite regions has produced conditions so abnormal in that branch of the mining industry that a census taken as of the year in which the strike occurred would result in data misleading and unsatisfactory.
>
> It is the judgment of all the gentlemen with whom I have consulted that the fact of the anthracite coal strike does not constitute a good and sufficient reason for postponing the census mining inquiry, and in this judgment I concur. It is the opinion of Mr. Walcott that the statistics of anthracite coal mining can be taken as of the year 1901 so far as quantities and values are concerned. It is suggested by Commissioner Wright that statistics of the anthracite coal mining industry, taken as of the year 1901, so far as quantities and values are concerned, and as of the year 1902, so far as relates to other items, will prove of great value in the immediate future in connection with the discussion of the controversy which has arisen between the coal operators and the coal miners of the anthracite region, and that Congress and the people of the United States ought to have the benefit of such statistics in view of important economic questions arising from the strike in question. Colonel Wright also suggests that certain questions having a direct bearing upon the existing situation in the anthracite coal region may with propriety be added to the special schedule adopted for that branch of the mining industry.
>
> I therefore recommend that the division of manufactures shall continue and perfect its plans for taking a mining census as of the present calendar year, with a view to the commencement of fieldwork early in the year 1903.
>
> Such a course was undoubtedly contemplated by Congress in the passage of the act providing for a permanent Census Office, approved March 6, 1902. It is true that the portion of section 7 of the act in question which undertakes to fix the date for the mining census is difficult of intelligent interpretation in the form in which it was enacted, but an examination of the debate in the House of Representatives at the time when the words "until July first, nineteen hundred and four," were inserted in the bill in the form of an amendment offered by Mr. Williams, of Mississippi, reveals the fact that the purpose of these words was to restrict the Census Office to a single report upon the mining industry and to exclude annual reports, and that it was intended that this should be taken and published prior to the date named. In order to comply literally with the intent of Congress, as revealed in the debates of the House in connection with this amendment, it will be necessary to take the mining census as of the calendar year 1902.

With reference to the plans for the mining census, I respectfully recommend that the inquiry be divided into three parts, as follows: Part 1, Precious metals; Part 2, Stone quarrying of all descriptions; Part 3, All other minerals, metallic and nonmetallic.

I also recommend that the details of the work for each part shall be under the immediate direction and within the complete control of the chief statistician for manufactures and his assistants.

I recommend the appointment of Mr. I. A. Hourwich, of Washington, D. C., as consulting expert special agent for the precious metals, at a compensation of $6 per diem when actually employed. Mr. Hourwich was formerly connected with the Treasury Bureau of the Mint and is highly recommended by Director George E. Roberts. I make this recommendation with the understanding that Mr. Hourwich is to have access to all the records and data of the Mint in connection with this work, and that the Census Office is to have the benefit of the cooperation of that bureau of the Government as the result of Mr. Hourwich's appointment.

For the second branch of the inquiry I recommend the appointment of Mr. George P. Merrill as consulting expert special agent. Mr. Merrill is one of the head curators of the National Museum, and this recommendation is made with the understanding that he will serve the Census Office without compensation, and that the office is to have the benefit of all the records and data of the National Museum so far as they relate to the stone quarrying industries of the United States.

For the third branch of the mining inquiry I recommend that a consulting expert special agent be appointed who shall be mutually agreed upon by the Director of the Census and the Director of the United States Geological Survey, and with the understanding that the Census Office is to have the use and benefit of the records and data of the statistical division of the Geological Survey in the prosecution of its work, in accordance with section 28 of the act of March 3, 1899, under such conditions as shall prove satisfactory to the Director of the Geological Survey and shall be mutually agreed upon.

I am of the opinion that it will be for the benefit of the Government if the mining statistics annually collected and published by the Geological Survey are collected for the year 1902 by the Survey and the Census Office, working in conjunction and cooperation with each other, thus avoiding a duplication of governmental statistical work, the whole expense of the inquiry for that year to be borne by the Census Office; and the Geological Survey to have the benefit and use of the statistics, so far as it may require them, contemporaneously with their use and publication by the Census Office.

The details of this plan, if it can be carried out, must necessarily be the result of consultation with the Director of the Geological Survey, and must include such arrangements regarding the clerks of the Survey employed in its statistical division and their payment during the period of the inquiry as may be mutually agreed upon.

All of which is respectfully submitted.

S. N. D. NORTH,
Chief Statistician for Manufactures.

The recommendations contained in this letter were approved, and preparations were immediately made for the mining census. These consisted of making ready the schedules and instructions, perfecting the details for cooperative work with the Geological Survey, getting together lists of mines and quarries, districting the entire country, and appointing special agents. Each of these stages of the work is explained at length under its appropriate title.

II.

DEVELOPMENT OF MINING STATISTICS.

Scope of the inquiry.—The census of 1840 was the first, except for the fragmentary information collated in 1810, to include statistics of mining and quarrying. Statistics were shown of capital, employees, and product—in combination, however, with the manufactures of the metal or mineral in each case—for coal, anthracite and bituminous; gold; granite, marble, and other stone; iron ore; and lead.

In 1850 and 1860 statistics for mines and quarries were included with those for manufactures. The first separate census of mines and quarries was in 1870; then followed the censuses of 1880 and 1890. Table 1 shows the character of the inquiries concerning mines and quarries from 1850 to 1902, as far as they are disclosed by the published results.

The subjects presented from 1850 to 1902 are shown in Table 2, which makes very plain the development in this respect during the little more than a half century which has elapsed.

TABLE 1.—CHARACTER OF INQUIRIES CONCERNING MINES AND QUARRIES: 1850 TO 1902.

	1850	1860	1870	1880	1890	1902
Number of establishments	×	×	×	......	......	......
Number of mines	......	......	......	×	×	×
Number of operators	......	......	......	......	......	×
Capital	×	×	×	......	......	......
Capital, by classes	......	......	......	×	×	......
Capitalization, etc., of incorporated companies	......	......	......	......	......	×
Wage-earners, by sex	×	×	......	......	......	......
Wage-earners, classified as men and boys, above and below ground	......	......	×	×	......	......
Wage-earners, by occupation	......	......	×	×	......	......
Wage-earners (men and boys, above and below ground), by occupation	......	......	......	......	×	×
Average number of wage-earners (men and boys) employed during each month	......	......	......	......	......	×
Wage-earners (men and boys), by occupation and daily rates of pay	......	......	......	......	......	×
Wages, total	×	×	×	×	......	......
Wages, by sex, of wage-earners	×	×	......	......	......	......
Wages of men and boys, above and below ground, by occupation	......	......	......	......	×	×
Cost of supplies and materials	×	×	×	×	×	×
Product, value	×	×	×	×	×	×
Product, quantity	......	......	×	×	×	×
Power and machinery	......	......	×	×	×	×
Salaried officials	......	......	......	×	......	......
Salaried officials and salaries, by sex	......	......	......	......	×	......
Salaried officials and salaries, by occupation	......	......	......	......	......	×
Contract work, amount paid	......	......	......	......	×	×
Contract work, number of employees	......	......	......	......	......	×
Miscellaneous expenses, total	......	......	......	......	×	......
Miscellaneous expenses, in detail	......	......	......	......	......	×
Character of ownership	......	......	......	......	......	×
Time in operation (or idle)	......	......	......	......	......	×

TABLE 2.—SUBJECTS INCLUDED IN CENSUS REPORTS CONCERNING MINES AND QUARRIES: 1850 TO 1902.

Inquiry introduced.	Group.		1850	1860	1870	1880	1890	1902
1850	Metallic	Gold mining	×	×	......	......	(1)	......
		Gold rockers	×	......	......	......	......	......
		Silver mining	......	×	......	......	(1)	......
		Gold and silver assaying and refining ("reduced and refined" in 1870)[2]	......	×	×	......	......	......
		Gold quartz	......	......	×	......	......	......
		Gold and silver quartz	......	......	×	......	......	......
		Silver quartz	......	......	×	......	......	......
		Quartz milled	......	......	×	......	......	......
		Gold, hydraulic mined	......	......	×	......	......	......
		Gold, placer mined	......	......	×	......	......	......
		Gold, hydraulic, placer, etc.	......	......	......	×	......	×
		Gold and silver, deep mines	......	......	......	×	......	×
		Gold and silver	......	......	......	......	×	......
		Iron ore	×	×	×	×	×	×
		Brown hematite	......	......	......	......	(1)	(1)
		Red hematite	......	......	......	......	(1)	(1)
		Magnetite	......	......	......	......	(1)	(1)
		Carbonate	......	......	......	......	(1)	(1)
		Lead	×	......	×	(1)	(1)	(1)
		Lead mining and smelting	......	×	......	......	......	......
		Zinc	......	×	×	(1)	(1)	(1)
		Lead and zinc ore	......	......	......	×	×	×
	Fuels	Coal	×	......	......	......	......	......
		Coal, anthracite	......	×	×	×	×	×
		Coal, bituminous	......	×	×	×	×	×
	Structural materials	Slate	×	×	×	×	×	×
		Stone and marble quarries ("marble and stone work" in 1850)	×	×	......	......	......	......
		Stone	......	......	×	......	......	......
		Marble	......	......	×	×	×	×
		Sandstones and quartzites ("sandstone" prior to 1902)	......	......	......	×	×	×
		Siliceous crystalline rocks	......	......	......	×	(5)	×
		Marble and limestone	......	......	......	×	......	......
		Magnesian limestone	......	......	......	×	......	......
		Limestones and dolomites ("limestone" in 1890)	......	......	......	......	×	×
		Bluestone	......	......	......	......	×	(4)
		Granite	......	......	......	......	×	(5)
	Abrasives	Buhrstones	×	......	......	......	......	......
		Millstones[3]	×	×	×	×	×	......
		Buhrstones and millstones	......	......	......	......	......	×
		Grindstones and pulpstones ("grindstones" prior to 1902)[2]	×	×	×	×	(6)	×
	Chemicals	Gypsum (plaster) ("plaster, ground," in 1870)[2]	×	×	×	......	×	×
	Pigments	Ocher	×	×	×	×	......	......
		Paints	......	......	......	......	×	......
		Mineral pigments, crude	......	......	......	......	......	×
	Miscellaneous	Cement ("hydraulic cement" in 1880)[2]	×	×	×	×	×	×
		Chrome ore	×	×	......	×	×	×
		Mica ("isinglass" in 1860)	×	×	×	×	×	×

[1] Production only.
[2] For comparative purposes considered as mining and quarrying.
[3] See "granite."
[4] Included in "sandstones and quartzites."
[5] Included in "siliceous crystalline rocks."
[6] Given under "stone."

TABLE 2.—SUBJECTS INCLUDED IN CENSUS REPORTS CONCERNING MINES AND QUARRIES: 1850 TO 1902—Continued.

Inquiry introduced.	Group.		1850	1860	1870	1880	1890	1902
1860	Metallic	Copper ore		×	×	×	×	×
		Copper, milled and smelted[1]			×			
		Manganese ore		×		×	×	×
		Nickel and cobalt		×			×	×
		Nickel ore		×	×	×		
		Nickel, smelted[1]			×			
		Cobalt				×		
		Nickel and cobalt matte				×		
		Quicksilver		×			×	×
		Quicksilver, smelted[1]			×			
		Cinnabar			×			(2)
	Fuels	Petroleum ("oil, coal," in 1860)		×	×	×	×	×
	Structural materials	Clay		×				×
		Paper clay		×				
		Fire clay		×	×			(3)
		Kaolin				×		(3)
		Ball clay						(3)
		Stoneware clay						(3)
		Pipe clay						(3)
		Terra cotta clay						(3)
		Water lime ("hydraulic lime" in 1880)		×		×		
	Abrasives	Corundum		×			×	
		Emery		×				
		Emery, reduced and ground[1]			×			
		Corundum (emery)				×		
		Corundum and emery						×
		Oilstones		×		×		
		Whetstones		×		×		
		Scythestones		×		×		
		Scythe rifles		×				
		Hones and whetstones[1]			×			
		Shoemaker's sandstone		×				
		Oilstones, whetstones, and scythestones ("whetstones" in 1890)					×	×
	Chemicals	Sulphur					×	
		Pyrite ("pyrites" in 1890)				×	×	
		Sulphur and pyrite						×
	Pigments	Barytes		×	×	×	×	×
	Miscellaneous	Asphaltum and bituminous rock ("asphaltum" prior to 1902)		×	×	×	×	×
		Graphite ("plumbago, black and silver lead" in 1860)		×	×	×	×	×
		Magnesite ("magnesia" in 1860)		×		×		
		Silica sand ("glass sand" in 1860 and 1880; "silex" in 1870)		×	×	×		×
		Soapstone		×	×	×		
		Talc						
		Talc and soapstone ("soapstone" in 1890)					×	
1870	Fuels	Peat (cut)			×			
1880	Abrasives	Garnet				×		
		Infusorial earth				×		
		Infusorial earth, tripoli, and pumice					×	×
	Chemicals	Borax[1]				×		×
		Phosphate rock ("phosphates" in 1880)[1]				×	×	×
	Miscellaneous	Asbestos				×	×	×
		Mineral soap				×	×	
		Quartz and feldspar				×		
		Flint						×
		Feldspar						×
1890	Metallic	Aluminum					×	
		Antimony					×	
		Platinum					×	
		Tin					×	
	Fuels	Natural gas					×	×
	Chemicals	Fluorspar					×	×
	Miscellaneous	Lithographic stone					×	
		Marl					×	×
		Ozocerite					×	
		Precious stones					×	×
1902	Abrasives	Crystalline quartz						×
	Miscellaneous	Bauxite						×
		Fuller's earth						×
		Lithium ore						×
		Molybdenum						×
		Monazite						×
		Rutile						×
		Tungsten						×
		Uranium and vanadium						×

---

[1] For comparative purposes considered as mining and quarrying.

[2] Included with "quicksilver;" production reported separately.

[3] Production only.

The census of 1850 was the first at which a complete enumeration of industrial establishments was attempted. It was also the first at which answers were required to definite questions concerning capital, labor, materials, and products, but at this and the census of 1860 the statistics for mines and quarries were subsidiary to those for manufactures, the enumeration being made by the same agencies and the statistics included in the same tables. At the census of 1870 the statistics of mining were presented separately. The defects incident to the collection of statistics for manufactures were intensified in those for mining. It was impossible for the United States marshals and their assistants to make a complete enumeration of mines and quarries, many of which were in remote localities and the schedules used were not in proper form to secure satisfactory information from the mines and quarries that were reported.

The following comparative table is introduced to show the character of the statistics reported for mines and quarries at prior censuses and to illustrate the absence of comparative data on any phase of the industry other than possibly the quantity and value of products. The figures for 1889 in this table do not agree with those in Table 4 for the reason that certain industries not considered mining have been eliminated in order to make the totals comparable; nor do they agree with those in Table 1 of Chapter II because they include only the minerals contained in the body of the report of the Eleventh Census.

TABLE 3.—MINING STATISTICS REPORTED AT CENSUSES: 1850 TO 1902.

	1902	1889	1880	1870	1860	1850
Number of mines or quarries	151,516	59,204	[1] 22,404	[2] 8,775	[2] 9,328	[2] 3,261
Number of operators	46,858					
Capital	(3)	$1,287,709,840	$1,148,808,032	$245,757,606	$95,863,730	$16,750,768
Salaried officials, clerks, etc.:						
Number	38,128	6,120	(4)	(4)	(4)	(4)
Salaries	$39,020,552	$4,724,302	(4)	(4)	(4)	(4)
Wage-earners:						
Average number	581,728	[5] 523,710	295,991	163,185	[6] 100,754	[7] 34,209
Total wages	$369,952,960	[5] $212,076,848	[8] $94,771,944	$79,440,551	$39,880,010	$12,266,236
Above ground—						
Men 16 years and over	215,298	210,961	116,792	74,684	(4)	(4)
Boys under 16 years	6,219	20,969	15,033	7,256	(4)	(4)
Below ground—						
Men 16 years and over	354,585	281,841	153,818	77,232	(4)	(4)
Boys under 16 years	5,638	10,026	9,728	4,013	(4)	(4)
Contract work	$30,677,938	$6,719,581	(3)	(3)	(3)	(3)
Miscellaneous expenses	$71,771,713	$30,236,132	(3)	(3)	(3)	(3)
Cost of supplies and materials	$123,814,967	$74,288,181	$31,447,488	$41,869,920	$25,154,924	$5,049,841
Value of products	$796,826,417	$410,760,770	$251,967,065	$191,002,563	$89,544,435	$29,826,699

[1] Mines, quarries, wells, and establishments.
[2] Establishments.
[3] Not reported.
[4] Not reported separately.
[5] Includes foremen and their wages.
[6] Includes 173 "female hands."
[7] Includes 130 "female hands."
[8] No wages were given for wage-earners in stone quarries.

The number of minerals for which statistics were shown at the census of 1860 would indicate that about all branches of mining followed at that time were included. It is impossible, at this late day, to determine the degree of completeness obtained in the statistics of minerals and mining operations collected at the censuses of 1850 and 1860. It is certain, however, that there was a great deficiency in the 1860 statistics of iron ore. The following statement appears in the Report on Manufactures for 1860, page clxxvii: "Many of the large iron works of the country either own or farm the mineral lands and mine their own ore, which is not included in the foregoing product. The quantity thus raised in 1860 amounted to about 2,309,975 tons, which, added to the product of regular mining establishments, makes the total quantity raised in 1860, 3,218,275 tons. At an average cost price of $2.40 per ton the total value would be $7,723,860." This indicates that more than two-thirds of the iron ore mining operations were omitted from the enumeration, but it is probable that they were included with the statistics of blast furnaces.

Census of 1870.—In 1870 the statistics for the mining industries were presented separately from those for manufactures. Totals were shown for the United States and for each state and territory, also for each mineral in each state by counties. The statistics were accompanied by a short explanatory text, which declared that they were entirely inadequate and fell far short of the total production. At 1870 and prior censuses the statistics, whether for mines, manufactures, or fisheries, were all collected upon a schedule having the same form. The scope of the inquiry was thus necessarily limited. The census of 1870 was supposed to cover all mines and quarries as it did manufactures, but mines and quarries where the annual production did not exceed $500 were not taken. The separation between the mining and manufacturing industries, first attempted at this census, appears to have been made with the intention of including under manufactures all work on the ore after its delivery at the mouth of the mine.

In presenting the statistics Hon. Francis A. Walker, Superintendent of the Census, stated that "the statistics following are of very unequal value, for the reason that the machinery of enumeration provided by the census law of 1850 was created without consideration of certain of the great mining industries of the country, * * * and can not be applied to them with any degree of success. It may fairly be taken for granted that an attempt to enumerate cotton spinning, coal mining, and cod fishing on one and the same schedule will always result in returns unsatisfactory in respect to one if not two of the three industries so widely diverse in character and conditions."[1]

With regard to the statistics for the precious metals Superintendent Walker says: "The statistics of the gold and silver product, as obtained by the census, are here published in conformity with what is understood to be the requirement of law; but it would be wholly unjustifiable were the figures to be put forth without a distinct and emphatic disclaimer of their validity and authority."[2]

Census of 1880.—The incomplete and defective character of the statistics at the census of 1870 and prior censuses led to the adoption of entirely different methods at the census of 1880. The scope of the inquiry was greatly extended, special schedules were introduced, and the conduct of the canvass and the compilation of the statistics were assigned to experts selected from the force of the United States Geological Survey. The inquiry not only covered the occurrence of minerals, employees and wages, and details as to the quantity and value of the different products, but extended to an analysis of the different leading minerals and the collection of numerous specimens. The report included statistics for manufacturing processes, such as lead, zinc, and copper smelting and refining, the refining of precious metals, and of petroleum. A directory of mines and metallurgical establishments was also included in the report. The purpose of the inquiry, as stated in the Instructions to Special Agents, was "to elucidate as far as practicable, the character, extent, and total influence of the mining industry. No industry has ever been examined throughout an extensive region so fundamentally and minutely as it is intended that the mineral industry of the West shall have been when this inquiry is successfully accomplished. The results will be a great addition to the data of political economy and will form a systematic accumulation of technical facts, such as does not at present exist."[1]

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[1] Ninth Census of the United States, Industry and Wealth, page 748.

[2] Ibid., page 750.

The subjects covered by the schedules for the precious metals are as follows:

- Metallic mines.
- Hydraulic mines.
- Hydraulic ditches.
- Ore-dressing works.
- Amalgamating mills.
- Stamp batteries.
- Pan amalgamation.
- Roasting furnaces in amalgamating works.
- Alternate amalgamation and concentration of battery sands.
- Alternate concentration and amalgamation of battery sands.
- Arrastras.
- Smelting works in general:
  - Preliminary operations.
  - Smelting in shaft furnaces.
  - Smelting in reverberatory furnaces.
  - Desilverization by zinc.
  - Pattinsonizing.
  - Improving of lead.
  - Cupellation.

In addition to the above, special schedules were provided for copper, iron, and lead and zinc mines, and quicksilver production; coal mines, farmers' coal diggings, petroleum wells, slate and stone quarries, charcoal burning, and minor minerals.

All mines were included, irrespective of the value of their products, and the irregular workings were enumerated. The census, so far as it related to precious metals, was limited to mines which showed at least 200 feet of shafts and galleries or which produced 50 tons or more of remunerative ore. The enumeration was not intended to be complete, but was apparently planned with a view to obtaining as large a number of representative facts as possible from which to draw general deductions.

As a census report the work was a failure, but as a scientific and technical report it has considerable value. The reasons for the failure of the 1880 census of the precious metals are concisely stated as follows: "After the work had been some time under way, it was found that both the time and the money which could be allotted to this branch were inadequate to carry it through with the perfection aimed at; that it was impossible to find the number of men required who were in every respect fitted for it by education and experience; and that among owners and superintendents of mines and reduction works, while with a very few unimportant exceptions the greatest willingness was shown to grant us all the information they possessed, it was often found that they were themselves unable to answer the questions we asked, either through want of system in keeping records, or because they had never thought of the importance or bearing of certain facts."[2] If the general canvass of all mines had been confined to the collection of a few main facts and the special technical features to representative mines, the work would have met with a larger measure of success.

The failure of the census of 1880 was apparently accepted as demonstrating the impracticability of including a large number of inquiries on technical and scientific subjects in a schedule to be used for a general canvass of all mines and quarries. The establishment in 1879 of the Geological Survey, and the collection by that office of technical and scientific information concerning the mineral resources of the country, obviated the necessity for the collection of such information by the Bureau of the Census. Therefore the scope of the census of 1890 was considerably curtailed, but followed in a general way the plan outlined in 1880.

Census of 1890.—The statistics for the mining census of 1890 are contained in a volume entitled "Mineral Industries." This report presents detailed statistics for each mineral, but no summary is given of the totals for all, though the following figures purporting to show the totals for the mining industry are obtained from the introduction to the report:

Employees	636,419
Wages paid	$265,290,643
Other expenditures	$115,874,135
Value of products	$587,230,662

The data given in the body of the report for each mineral are summarized in Table 4.

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[1] Tenth Census of the United States, Precious Metals, Vol. XIII, page 493.

[2] Tenth Census of the United States, Precious Metals, Vol. XIII, page xi.

TABLE 4.—SUMMARY OF MINERAL INDUSTRIES: 1889.

MINERAL.	Number of mines, quarries and wells.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.								Miscellaneous expenses.	Supplies and materials.	Value of product.
					Aggregate.		Above ground.			Below ground.					
			Number.	Salaries.	Number.	Wages.	Total	Men.	Boys.	Total.	Men.	Boys.			
Total	59,494	$1,310,535,318	6,541	$5,520,600	536,043	$222,041,887	244,127	223,229	20,898	291,916	281,880	10,036	$39,521,506	$86,075,925	$438,111,548
Aluminum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	97,335
Antimony	...	...	...	...	28	[1]12,218	7	7	...	21	21	...	[2]7,145	3,869	28,000
Asbestos[3]	...	42,000	1	...	11	2,700	8	8	...	3	3	...	...	525	1,800
Asphaltum	...	2,651,500	2	3,000	131	63,503	119	119	...	12	12	...	[2]17,950	13,884	171,537
Barytes	...	351,150	...	...	215	[1]54,524	45	40	5	170	170	...	2,083	8,200	106,313
Chromic iron ore	6	8,000	...	...	30	6,000	[4]30	30	...	...	...	...	...	[5]4,000	30,000
Coal	[6]12,552	342,757,929	2,936	2,193,870	296,623	106,937,058	67,137	49,301	17,836	229,486	219,690	9,796	[7]18,576,762	18,928,590	160,226,323
Copper	[8]11	74,984,737	147	266,108	13,508	9,885,623	7,350	7,214	136	6,158	6,075	83	[2]2,348,588	10,093,587	[9]19,686,592
Corundum	[10]4	73,400	...	...	129	44,660	55	55	...	74	74	...	[2]3,062	9,383	105,565
Fibrous talc	...	...	...	...	...	...	...	...	...	...	...	...	...	...	244,170
Fluorspar	...	192,000	...	...	101	14,215	73	71	2	28	28	...	3,008	5,025	45,835
Gold and silver[11]	3,729	496,323,338	873	1,347,373	56,434	40,412,022	22,025	21,943	82	34,409	34,366	43	[2]7,874,002	13,817,739	99,283,732
Graphite	...	239,175	...	...	101	38,329	25	25	...	76	76	...	[2]8,678	7,734	72,662
Gypsum	[12]24	2,473,175	...	...	761	[1]249,200	586	579	7	175	175	...	[2]55,290	128,854	764,118
Infusorial earth	...	110,750	...	...	52	8,398	52	52	...	...	...	...	[2]7,580	760	23,372
Iron ore	592	109,766,199	520	529,043	37,707	13,880,108	17,999	17,290	709	19,708	19,597	111	[2]5,373,519	4,998,998	33,351,978
Lead and zinc[13]	[14]21	5,518,499	358	672,029	12,052	6,874,581	11,186	10,979	207	866	863	3	[2]2,066,729	6,215,925	[15]15,335,360
Lithographic stone	1	...	...	...	3	154	3	3	...	...	...	...	228	200	243
Manganese	...	2,188,950	...	...	432	128,958	[4]432	432	...	...	...	...	...	...	[16]240,559
Marl	[17]3	...	...	...	...	...	...	...	...	...	...	...	...	...	63,956
Metallic paint	...	462,164	8	5,540	191	69,820	191	188	3	...	...	...	[2]22,929	65,498	286,294
Mica[3]	4	691,550	...	...	185	42,174	185	185	...	...	...	...	8,753	7,408	52,450
Millstones	...	54,945	...	...	99	17,555	99	97	2	...	...	...	[2]2,118	1,413	35,155
Mineral waters	[18]258	5,991,683	...	...	...	435,583	...	...	...	...	...	...	210,304	524,864	1,748,458
Natural gas	[19]2,247	[20]59,682,151	411	290,403	6,273	1,445,986	6,273	6,267	6	...	...	...	...	13,184,497	21,097,099
Nickel and cobalt	...	279,000	6	9,600	181	84,200	113	103	10	68	68	...	[2]3,151	29,236	[21]40,000
Ocher	...	398,453	...	...	196	[1]59,695	196	193	3	...	...	...	7,541	19,011	177,472
Ozocerite	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,500
Petroleum	[19]35,163	[20]114,157,570	173	163,156	22,366	8,583,744	22,366	22,210	156	...	...	...	...	9,505,935	26,963,340
Phosphate rock	[22]25	6,131,718	...	...	5,011	[1]1,200,151	5,011	4,920	91	...	...	...	[2]459,201	317,159	2,937,776
Platinum and iridium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,000
Precious stones	...	...	...	...	299	148,355	299	187	112	...	...	...	[2]55,762	...	188,807
Pyrites	...	1,358,892	...	5,512	237	62,379	108	86	22	129	129	...	[2]53,365	42,000	312,119
Quicksilver	11	1,221,114	20	34,966	937	580,042	416	412	4	521	521	...	[2]46,771	219,622	1,190,500
Soapstone	...	924,900	...	...	280	[1]115,621	280	268	12	...	...	...	[2]12,363	35,454	231,708
Stone	4,163	90,212,433	1,086	...	81,288	[1]30,555,877	81,288	79,807	1,481	...	...	...	2,293,706	7,923,220	53,035,620
Sulphur	2	320,750	...	...	12	2,410	12	9	3	...	...	...	...	1,700	7,850
Tin	[23]678	898,000	...	...	79	202,047	67	67	...	12	12	...	...	[5]60,817	[24]
Whetstones	...	57,540	...	...	91	21,911	91	82	9	...	...	...	[2]1,055	838	32,980

[1] Includes salaries.
[2] Includes amount paid contractors.
[3] Statistics, except those of production, refer also to mines at which development work was done.
[4] Not separated into above and below ground.
[5] "Other expenditures."
[6] Including 9,969 "local mines," the product only of which is shown.
[7] Includes contract work.
[8] Stamp mills; number of mines or establishments otherwise not given. Statistics include those for stamp mills, concentrating plants, and copper refining.
[9] Value of product is that of copper refined.
[10] Firms; from textual statement, page 711: "The entire industry is controlled by three or four firms."
[11] Includes reduction works.
[12] Producers; from textual statement, page 700: "There were 24 producers who used steam power at their works."
[13] Includes smelting and refining.
[14] Smelting works.
[15] Value of product of zinc and lead mines, and, in some cases, value of ore treated by smelters and refiners; other statistics include smelting and refining.
[16] Not including value of manganiferous zinc ore, which was $54,500 at the mines.
[17] Organized companies.
[18] Springs.
[19] Producing wells.
[20] Includes value of pipe lines.
[21] Includes value of matte at mines, but not the value of other smelted nickel ores.
[22] Number of establishments given for South Carolina only.
[23] Number of openings.
[24] No production during the census year.

The totals for the United States, as shown by Table 4, are considerably less than the total referred to in the introduction to the report of the Eleventh Census. There is apparently no explanation of this difference, but it is believed that the figures given in Table 4 represent actual conditions as nearly as they can be ascertained from the data furnished at the Eleventh Census. Table 4 includes statistics for the following, which are not considered as forming a part of the mining census of 1902, i. e., aluminum, copper smelting, lead smelting and refining, and spelter and oxide of zinc, and mineral waters. Lack of uniformity is apparent in the statistics for the different minerals shown in Table 4. To illustrate: For aluminum and fibrous talc, marl, and ozocerite, product only is reported; for antimony, the number of establishments, capital, salaried employees, or salaries are not reported. The number of establishments and miscellaneous expenses are not reported for asbestos, while the production is given for California only, though the expenditures evidently include the nonproducing mines in Wyoming.

In addition to the mining statistics, the census of 1890 included statistics for the smelting and refining of gold, silver, copper, and lead and zinc. The statistics apparently included all reduction works, though the general line of demarcation between manufacturing and mining agrees very closely with that followed in the canvass of the Twelfth Census. In the Report of Mineral Industries at the Eleventh Census it was stated that "the subjects taken for the investigation included all minerals which would have a definite market value, wherever they occur, provided the deposit contained the mineral in sufficiently pure form. This ruled out such minerals as ice, water (except mineral waters), sand for street paving, and other materials the condition of which is not changed, but which are simply made valuable by the work of placing in a special position, as earth for embankments."

"In the treatment of the various subjects the limit of the mining features was considered as reached when the product became a regular article of commerce."[1]

The following minerals were apparently produced in commercial quantities in 1889, though the report contains no data concerning them, i. e., borax, bauxite, cement, flint, feldspar, potters' clay, and rutile.

Census of 1902. The scope of the census of mines in 1902, as stated in the act approved March 6, 1902, providing for a permanent Census Office, was intended to embrace the collection of statistics relating to "mines, mining, quarries, and minerals, and the production and value thereof, including gold in divisions of placer and vein, and silver mines, and the number of men employed, the average daily wage, average working time, and aggregate earnings in the various branches and aforesaid divisions of the mining and quarrying industries."

The purpose was to include in the enumeration the processes involved in the extraction from the earth of mineral products of all kinds. To accomplish this successfully the special agents engaged in the fieldwork were instructed to secure reports for all mines and quarries, and for reduction works connected with mines or engaged in reducing the ores containing the precious metals. It is believed that this census is as broad and as comprehensive in its scope as any of its predecessors; certainly it may be claimed that the canvass has been more complete than any statistical inquiry heretofore made concerning the mines and quarries of the United States.

No restrictions or limitations were established as to the size or importance of mines and quarries to be enumerated, except that the special agents were instructed to eliminate from the inquiry small placer gold mines at which less than two wage-earners were employed. The schedules received bear evidence that in many instances this instruction was not followed, and the reports included a number of small mines operated without hired labor.

Mineral springs were omitted from the canvass for the reason that in most cases the production is entirely spontaneous and does not require the employment of capital or labor except to place the product upon the market in the form of bottled mineral waters.

The production of salt was also omitted for the reason that a thorough canvass of the inquiry had been made in 1900 for the census of manufactures. The statistics are presented, with a report on the subject, in Part III of the Report on Manufactures.

What appears to be a serious defect in the published results of some of the earlier censuses is the absence of summaries showing the statistics other than those for quantity and value of product. Complete summaries by states and by industries for the United States, and for each industry by states and each state by industries were published at the census of 1870. At the census of 1880 a similar summarization was made for bituminous coal and lignite, anthracite coal, iron ore, copper ore, lead and zinc ore, and the minor minerals, but the absence of uniformity in the collection of statistics was referred to in the report of that census as follows: "It will therefore be seen that the duties of this office in regard to the statistics of mining were very different in different parts of the country, and further that the statistics were collected on blanks of different forms. The lack of uniformity in this respect added greatly to the difficulty of tabulation."[2]

The statistics for 1902 are presented in this report in summarized form and in detail. The tables show the statistics for the United States by states and by industries. Each industry is also presented by states and each state by industries. In connection with the reports on the different minerals, tables pertinent to the subject are presented.

A careful study of the statistics for the different censuses leads to the conclusion that there are no reliable comparative data for all mines and quarries other than the quantity and value of products.

The development of mining statistics may be considered as dating from the Tenth Census. The principal features of this development have been: (1) The separation of the statistics for mines and quarries from those for manufactures; (2) the adoption of special schedules designed to accentuate the peculiar features of the different minerals; (3) the employment of expert special agents to collect and present the data; (4) the collection of statistics in collaboration with the United States Geological Survey.

Mining and manufacturing.—Separate schedules were first provided for the mining industries at the census of 1880. Prior to that date the statistics had been collected in connection with the census of manufactures, the same schedule being applied indiscriminately to large manufacturing establishments, small shops, mines, quarries, and fisheries.

In some cases the mining industry is restricted to the digging of ore and the quarrying of rock—that is, to the minerals as delivered f. o. b. at the mine or quarry. In others a certain amount of labor is expended in the preparation of the product for the market. All labor expended on material after it is taken from the earth may be regarded as employed in manufacturing, and a strict demarcation between the two industries would so assign all such processes, but it is impossible in many instances to make this separation. To assist in the separation where possible and to aid in a more definite statistical presentation, all mines can be arranged in two groups: (1) Those where the product is marketed in the form in which it is extracted from the earth; (2) those where the initiatory manufacturing process is necessarily done at the mine or in immediate connection therewith.

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[1] Eleventh Census of the United States, Mineral Industries, page ix.

[2] Eleventh Census of the United States, Mining Industries (excluding Precious Metals), Vol. XV, page xvii.

No attempt was made to segregate the statistics for the two branches of industry, mining and manufacturing, respectively, prior to the census of 1870. At that census the distinction between mining and manufacturing was sharply defined, and the statistics for mining were presented in a separate series of tables. The reasons for the distinction were given as follows:

> (1) Because these industries are in theory and in their practical relations essentially distinct. * * * The occupation of the miner is not so much unlike that of the artisan, yet writers on political economy have been quite generally disposed to hold that if the occupations of mining and fishing are to be assigned to any one of the three grand divisions of industry which have been indicated, it should be to agriculture, as dealing in the spontaneous products of the earth and the sea, and also as furnishing material in the earliest forms for subsequent processes of industry.
>
> (2) For convenience of reference and citation. The statistics of mining * * * occupy so little space comparatively as not to be easily found upon occasion in voluminous tables of manufactures.
>
> (3) Because the statistics of mining * * * with the present modes of collection are distressingly inadequate to the known facts of the case, and their addition to the tables of manufacturing industry amounts to a positive disparagement of the latter. The statistics of manufactures have their own faults, as is elsewhere frankly acknowledged, under the present census system of the United States, but they are incomparably more complete and accurate than any statistics of mining * * * to be obtained by existing machinery. To merge them with matter so defective is, in a degree, to subject them to the same discredit. A separation, therefore, is on all accounts desirable.[1]

The separation at the census of 1870 was effected in some cases by means of correspondence with the mine operators, so far as they were disposed to afford the information, and in other cases by estimates prepared according to approved formulas at the Bureau of the Census. The theoretical division between mining and manufactures thus applied is not wholly practical. Companies, firms, and individuals that operate both a mine and a reduction works, or that break, wash, screen, or roast the ore, almost invariably consider preparation for the market a part of the mining operations, and so report, insisting that the statistics can not be separated, since the employees were frequently engaged interchangeably on both branches of the work and no separate accounts were kept either of the wages or of other expenses.

At the census of 1880 the statistics related not only to mining, but included such technical data as to the various processes by which the metals are reduced from the ores as would serve to show the actual condition of the industry,[2] and therefore embraced manufacturing processes, such as the smelting of ores and the refining of petroleum. A more practical separation was attempted in 1890, but the statistics for that census also covered a number of manufacturing processes that are incident to the production of metal. At the census of 1902 the manipulation of the ore after it leaves the mine, if so interwoven with the business of mining as to be inseparable, has been considered a part of the mining industry. All other processes have been eliminated.

The combination of mining and manufacturing by the use of the same capital, the same wage-earners, etc., has been accentuated by the consolidation of industrial enterprises, carried to a high state of perfection during the past decade. If the statistics for mining and manufacturing were to be taken together it would be easy to find a common term for this union and comparatively simple to show the aggregate figures, but such work would not supply the demand for separate statistics for these important industries. Where the milling, separating, washing, burning, calcining, or other processes of reduction or manufacturing were carried out at the mine or quarry, the census of mines and quarries includes, as a rule, the employees, wages, miscellaneous expenses, and supplies and materials involved in the work of the entire establishment. At the census of 1902 the instructions to special agents on this subject were as follows:

> There are several branches of mining in which the mineral products do not reach the market in the crude condition, but are subjected to certain processes at the mine or quarry before being regarded as marketable commodities. These may be processes of milling, separating, washing, burning, calcining, or other forms of manufacture. In some industries these processes are performed entirely at the mine or quarry, and in such cases the special agents are instructed that the census schedule should include the statistics of employees and wages, miscellaneous expenses, and supplies and materials involved in the entire work of mining the crude material and preparing the same for market. For example, the following branches of mining and quarrying are of this character: Emery and corundum mines, where finished emery wheels are frequently manufactured; mica mines, sheet and crushed mica being the finished product; graphite mines, where the crude graphite is refined; grindstone and millstone quarries, where grindstones and millstones are the finished products; mines or quarries of kaolin, flint, ocher, barytes, manganese, chalk, talc, mica, umber, sienna, and other iron-oxide colors, where the crude mineral is ground or otherwise prepared; marble, granite, and other stone quarries, where the stone is cut and dressed and monuments and tombstones are manufactured; slate quarries, where roofing slate, slate blackboards, school slates, and sanitary plumbing slate slabs are manufactured. In all such cases as the foregoing and others where any form of manufacturing is necessary at the mine or quarry before the product is placed on the market, the Census schedule should cover the entire work of the establishment.

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[1] Ninth Census of the United States, Industry and Wealth, page 383.

[2] Tenth Census of the United States, Precious Metals, Vol. XIII, page x.

The practice followed and the line of demarcation adopted for the different minerals were as follows:

ABRASIVE MATERIALS:

Buhrstones and millstones: The quarries producing buhrstones and millstones almost invariably report the value of dressed stones, a segregation of actual quarrying operations from the finishing process being generally impracticable. The stones manufactured range in diameter from 14 to 84 inches, and are generally sold in pairs. A considerable by-product of paving blocks is included in the value of product reported by this industry.

Corundum and emery: These minerals are usually concentrated, cleaned, and pulverized at the mines, and the statistics are mainly those of the finished product.

Crystalline quartz: The value of the crude product is generally reported for this abrasive, although the crushing, drying, and screening operations incident to its preparation for use in the manufacture of sandpaper, garnet paper and cloth, etc., are in some instances carried on in connection with the quarrying. A segregation of quarrying and finishing operations is not always practicable, and of the total production reported, 20.9 per cent has been manufactured or finished to a certain extent after being taken from the quarry.

Garnet: Preliminary manipulation of the crude garnet ore is almost invariably carried on at the mines, and the cost of these finishing operations, consisting for the most part of the crushing of crystals to available sizes, washing, drying, and concentrating, is not separable from the expense of mining. The product reported for this abrasive may therefore be regarded as partly finished, and the value may be regarded as including somewhat more than that of the crude mineral.

Grindstones and pulpstones: A portion of the product of this abrasive is reported in the rough, that is, trimmed down for lathe finishing. The larger and more important establishments, however, complete the stone ready for mounting, in which instances the value reported is that of the finished product. Of the total production of grindstones, 71.9 per cent is a by-product of sandstone quarries. The capital and operating expenses for this part of the total production are therefore included in the statistics of the quarries in which the product was secured.

Infusorial earth, tripoli, and pumice: One-third of the product for this industry is reported by the Bureau of the Census as crude; this quantity represents about one-fourth of the total value. The remainder is finished at the mines by various processes. The process of working infusorial earth consists in burning and pressing into fire brick or drying, pulverizing, and bagging. The finishing of tripoli generally consists in burning, grinding, and washing, or, as is the case in the largest establishments of this kind, the product is manufactured by means of lathes, saws, and emery wheels into filter tubes, and disks, and shapes for water filters. The value reported for pumice is for the crude material. Its use, principally in the manufacture of certain kinds of soap, was by the company also controlling the mining operations; but the expense of this manufacture and the finished value of the product are not contained in this report.

Oilstones, whetstones, and scythestones: Of the total oilstone production in the United States 20.9 per cent is finished at the quarries, this amount representing 51.2 per cent of the total valuation. The finishing process, which consists in sawing or cutting the stone into strips averaging about 2 by 1½ by 8 inches and polishing these to a smooth surface, is necessary before the product is marketable. The crude value reported represents almost entirely the product of one company, owning quarries in various localities and shipping to one central plant for the finishing process. The United States Geological Survey reports the product of this company as it is finally manufactured, while the Bureau of the Census reports the production and value of the stone at the quarries.

Asbestos: Of the quantity shown for this mineral 59.9 per cent represents crude ore. The remainder was crushed, separated, and otherwise prepared at the mine for the market.

Asphaltum and bituminous rock: A large part of the asphaltum—elaterite, uintaite, etc.—was refined. Some of the bituminous rock was pulverized at the mine or quarry.

Barytes: The only preparation given this mineral at the mines was that of washing to free it, when necessary, from the associated earth or clay.

Bauxite: This mineral is usually sorted at the mine and subjected to solar or artificial heat to dry it prior to its shipment to market.

Borax: The product is that of refined borax, the crushing, grinding, mixing, crystallization, and other processes of refining being accomplished under the management of the mine owners.

Cement: In the case of cement the manufacture overshadows the mining of the raw material. Over 97 per cent of the Portland and natural-rock hydraulic cement production is made by establishments that mine, quarry, or excavate the raw material, and operate the mines or quarries and mills in conjunction. Only establishments excavating the whole or part of their raw material are included in the statistics. Although the reports do not permit of a complete segregation of the labor and expense for the mining and manufacturing processes, yet it would appear that in the case of the manufacture of natural rock cement the mining expense is not to exceed one-third of the cost of the marketable product, and in the case of Portland cement the portion on the side of mining or quarrying is very much less.

In the case of the cement companies using the marl deposits contiguous to the Great Lakes, which material is simply excavated with steam dredges, the cost of mining or excavation is an almost insignificant part of the cost of cement manufacture. Nearly 14 per cent of the Portland cement production was made from marl thus dredged or excavated.

Clay: Of the quantity of products shown, 17.3 per cent was prepared at the mine or quarry. This preparation consists principally of washing and grinding.

Coal, anthracite and bituminous: Anthracite coal is broken and screened and sometimes washed at the mine; bituminous is shipped as the run of the mine.

Copper ore: The reduction of the Lake Superior copper ores is done mechanically in stamp mills located at the mine, and the product, known as "copper mineral," is shipped to a smelter, operated either by the same or by some other company. As the stamp mill is in all cases regarded as part of the mine equipment, a thorough separation of the labor and expenses of the mine from those of the mill is impracticable; both have therefore been included in the mining census. The identity of the smelter, on the contrary, as distinct from the mine is maintained, as a rule, even in those cases in which it is owned and operated by the mining company. It has been possible, therefore, to eliminate smelters from the census of mines proper. The statistics for copper ores, other than those of the Lake Superior region, are generally for the crude ore; still in some cases the ore is dressed at the mines before smelting.

Flint and feldspar: The flint produced is properly quartz and not true flint, which is the nodular variety of silica occurring in calcareous strata, particularly in chalk. Approximately 52 per cent of the so-called "flint," or quartz, and feldspar production is marketed in its crude state and the balance as ground material. With the exception of the one process of grinding, the material is not subjected to manufacturing processes.

Fluorspar: Less than one-tenth of the quantity and about one-fifth of the value reported represents the product prepared at the mine for the market, the preparation consisting of washing, drying, and grinding.

Fuller's earth: The mining of fuller's earth is mere excavation and does not require skilled labor. The material is dried, ground, and in some cases sized, but is not otherwise subjected to manufacturing processes.

Gold and silver: The reduction or reworking of argentiferous and auriferous ores is carried on by establishments which, for the purpose of the mining census, are divided into four classes: (1) Reduction works, commonly known as "mills" (stamp and amalgamation, chlorination, cyaniding, and concentrating mills), which are located at the mine and operated by the mining company, the labor being employed interchangeably in the mining and the milling; (2) reduction works (mills) which are operated independently and in which the ore is either treated for a fixed compensation or purchased outright and the contents sold to smelters; (3) smelting establishments, which are usually operated independently, even when the mine and smelter are owned by the same company; (4) ore-dressing works (concentrators) which are operated by and in connection with the smelting establishments. The first two classes have been included in the mining census. The third class has been excluded, having appeared in the census of manufactures, 1900. The fourth class is so intimately allied with the smelting and refining of ores that it was impossible to make a separation, and therefore they have been classed also as manufactures.

Graphite: Almost the entire production reported is that of the mineral prepared for the market. The ore is crushed, stamped, separated, dried, and screened.

Gypsum: Nearly all of the gypsum quarried is calcined and manufactured into wall or cement plaster, and the manufacturing expense is the largest part of the cost of production of the marketable products. About 10 per cent of the gypsum quarried is reported as used in the crude state, and 7.4 per cent is ground for land plaster. The remaining 82.6 per cent is calcined into plaster of Paris, and most of the plaster of Paris is made into wall or cement plaster by the admixture of a retarder—fiber, hair, or other material.

Iron ore: Some of the ore is crushed, separated, calcined, and dried at the mines.

Lead and zinc ores: The dressing of these ores, preparatory to their final treatment by smelting, is usually done at the mine, either by hand jigs or in concentrating mills operated in connection with the mine; therefore no separation of labor and other expenses as between the mine and the mill is possible. There are a few custom mills which are not connected with any particular mine, but which either treat rough ores for a fixed compensation or purchase them outright and sell the dressed contents. Since the custom mills form but a small proportion of the total, all mills, whether connected with mining companies or independent, have been included in the mining census. Smelters, on the contrary, in those cases where they are owned by mining companies, as well as in all others, are operated as independent establishments, and they have not, therefore, been included in the mining census.

Lithium ore: This represents the crude ore, no manufacturing process being undertaken at the mine.

Magnesite: Of the quantity reported, 72.5 per cent was calcined at the mine, the remainder being the crude ore.

Manganese ore: The preparation usually given to the ore at the mine is crushing, washing, and screening.

Marl: The statistics presented in the report on marl pertain to the green sand marls of New Jersey and Virginia, which are used for fertilizing. One-third of the product is dried and ground, but with this exception the product is not subjected to any manufacturing process. The mining of marl is simply a process of excavation.

Mica: The statistics include such manufacturing processes as are involved in the removal of adhering fragments of flint and feldspar and such parts of the mica itself as contain foreign ingredients. The sheet mica is prepared by splitting the blocks into sheets, which are cut to a size.

Mineral pigments, crude: Most of the processes necessary for the marketing of crude pigments are undertaken at the mine. The ore is disintegrated by exposure to the atmosphere, roughly crushed, dried, pulverized, and screened or separated. The ground ore is sometimes levigated and the settled products dried.

Monazite: Monazite is obtained in placer mining; nearly all of it for which statistics are given was prepared at the mine for the market by washing and sometimes by concentration. A little of the mineral was concentrated electro-magnetically.

Natural gas: The statistics are for the product as piped from the wells, and the value is that received for it at the point of consumption.

Petroleum: The statistics shown are wholly for the crude product.

Phosphate rock: Rock phosphate is usually washed to free it from sand and other impurities and kiln-dried to free it from moisture. When mined in too large bowlders to be easily handled, it is crushed. This is all done at or near the mine. River pebble is washed and screened immediately after being pumped up from the river bottom, and is dried with hot air and screened again before being marketed.

Precious stones: The value is reported for the product in the rough state as mined or found.

Quicksilver: Almost the whole of the output is that of the quicksilver extracted from its chief ore, cinnabar; only a small part of the ore was reported unconcentrated.

STEEL HARDENING METALS:

Chrome ore: The statistics are for the ore as mined, none of it having been prepared at the mine.

Molybdenum: The molybdenite was reported as crude, no process of manufacture being given.

Nickel and cobalt: The statistics are for the nickel and cobalt ore, washed and then smelted into matte at the mine.

Rutile: The report is for the crude mineral, in no way selected or concentrated.

Tungsten: Some of the ore is concentrated to from 60 to 65 per cent tungsten oxide, but much of it is the crude as mined.

Uranium and vanadium: The values are for the crude ores from which these metals are derived, except that a few tons of the uranium ore was reported as concentrated.

STONE:

Limestones and dolomites: Of the total product 18.3 per cent in value was for building purposes, 17.3 per cent for blast furnace flux, and the value of lime burned 30.7 per cent, most of the remainder being crushed for concrete, railroad ballast, roadmaking, macadam, etc., or prepared for curbing and flagging.

Marble: Of the total product, 45.1 per cent was sold rough. The remainder was sold dressed, for building purposes, for interior decoration, and for monumental, ornamental, and other purposes.

Sandstones and quartzites: Of these, 29.4 per cent in value was sold rough; 27.2 per cent was disposed of dressed for building purposes; and the remainder was crushed for concrete, ballast, riprap, etc., or prepared for curbing and flagging.

Silica sand: This, as shown here, is the product of quarries, not of sand banks, and was generally obtained from rock pulverized at the mine.

Siliceous crystalline rocks: Of the whole product, 24.3 per cent in value was sold in the rough state; 26.6 per cent was dressed for building purposes; 12.5 per cent was prepared for monumental work; and the remainder was crushed for roadmaking, riprap, etc., or prepared for curbing, paving, flagging, etc.

Slate: The slate is split and cut into roofing slate or made into slates and slate pencils, sanitary slabs, etc., at the mines, as it is necessary to work the material when moist. The proportion of the value of product prepared for roofing was 86.9 per cent.

Sulphur and pyrite: The statistics for the sulphur are for the refined; for the pyrite they are, generally speaking, for the substance as picked, rolled, jigged, and assorted at the mine. Some pyrite was a by-product of coal mines, being picked from the refuse.

Talc and soapstone: The talc is almost all ground for the market, and the soapstone is manufactured into washtubs, slabs, sanitary ware, etc., nearly all the product mined being manufactured by the original producers. The foliated variety of talc is usually ground into talcum powder and the fibrous variety into material for paper filling. All these processes are accomplished at or near the mine.

The limitation of the census inquiry to the operations at the mine or quarry has resulted in the exclusion of a considerable portion of the values generally assigned to the mineral products of the country. These differences are fully explained in the special reports for each mineral. A comparison of the quantity of the ores as reported to the Bureau of the Census for the year 1902, with the quantity of the metal obtained from the same class of ore during the same period, but possibly mined, at least in part, during the preceding year, illustrates the disparity in the quantities. It is possible to make this comparison for a few minerals, and the totals are given in the following statement:

MINERAL.	Metal obtained, or manufactured product.	Product (quantity).
Iron ore, long tons		35,567,410
	Pig iron, long tons	17,821,307
Mineral pigments, crude, short tons.		35,479
	Mineral paints, short tons	[1]60,691
Gold and silver ore, short tons		[2]10,002,271
	Refined metal:	
	Gold, fine ounces	3,160,128
	Silver, fine ounces	42,766,061
	Copper, pounds	14,028,863
	Lead, short tons	205,519
	Zinc, short tons	35,780
Copper ore, short tons		11,780,064
	Refined metal	
	Gold, fine ounces	92,911
	Silver, fine ounces	11,452,290
	Copper, pounds	625,004,529
	Lead, short tons	276
Lead and zinc ores, short tons		623,662
	Refined lead, short tons	179,445
	Spelter, short tons	[1]156,927

[1] Reported by United States Geological Survey, zinc white and Venetian red omitted.

[2] Exclusive of placer bullion; this is shown in refined metal. Also exclusive of Alaska.

Special schedules.—At the census of 1840 the statistics for mines and quarries were collected on a schedule entitled "Schedule of mines, agriculture, commerce, manufactures, etc." The schedule used at the censuses of 1850, 1860, and 1870 was designated "Products of industry," and comprehended manufactures, mines, and fisheries. As already stated, the special schedules were introduced and carried to excess at the census of 1880, which was taken under the supervision of Gen. Francis A. Walker, who had already emphasized the necessity of such a schedule in presenting the statistics for the census of 1870. There were 44 special schedules, a separate schedule being provided not merely for each of the different minerals, except those tabulated as "minor minerals," but for the different conditions under which the same mineral was mined, and different sections of the country were assigned to different expert agents, and they in turn were permitted to use different forms of schedules for the same mineral as mined in their respective districts.

The use of special schedules was continued at the census of 1890, but the number of separate schedules was reduced to 23—1 general and 22 special. The special schedules were used to develop features peculiar to iron ore, gold and silver mines and reduction works, transportation of gold and silver ore and bullion, copper mines, lead mines, zinc mines, quicksilver mines and reduction works, manganese ore, precious stones, coal mines, distribution of coal for consumption, crude petroleum, natural gas, stone quarries, mineral waters, copper smelters and refiners, lead smelters and refiners, lead refiners, and zinc reduction works.

The object of the special schedule is to develop in detail the technique of an industry and to obtain from each establishment a schedule carefully filled out, the completion of which requires knowledge and time. The primary object of a census is to obtain complete and rapid enumeration, to show the magnitude of an industry, the number of people it employs, the amount paid in wages, and the quantity and value of its products. It is obvious, therefore, that these objects are in a measure antagonistic, and that the success of a census depends very largely upon the degree to which they can be harmonized. The schedules should not be so elaborate and technical that they can not be prepared by an agent of average intelligence, since they would so delay the canvass as to make a complete enumeration impossible.

The value of the statistics for a number of the minerals at the census of 1880 was seriously impaired by the adoption of a too elaborate and technical schedule.[1] The technical features of a special schedule are so interwoven with the general features to be developed by a census that it is, in many cases, impracticable to combine the two so as to obtain uniform statistics for all industries or all branches of the same industry. The use of special schedules is essential to the development of the census statistics for mines and quarries, but there are certain data—such as the number of different classes of employees, total wages, amount of miscellaneous expenses, cost of supplies and materials, and the quantity and value of the product—that should be called for uniformly in all such schedules. If these inquiries are not uniform it becomes impossible to make aggregates for all branches of industry. The omission of these general inquiries, and the lack of uniformity in the answers obtained in cases where they are included, are serious impediments to the use of the mining statistics of the censuses of 1880 and 1890.

The general tendency in statistical inquiries, as conducted by the Bureau of the Census, is to simplify the schedule.

An investigation designed to develop technical features can be conducted with better advantage and the results be more satisfactory if the inquiries are confined to representative establishments. Many of the inquiries concerning technical matters are not applicable to the major portion of the establishments enumerated, and therefore are confusing to the enumerator and to the person who furnishes the information.

The technical portions of the census of mines and quarries relate very largely to matters that are pertinent to the investigations of the United States Geological Survey, the results of which are given in the annual reports on the mineral resources of the United States. The collaboration between that office and the Bureau of the Census in the mining census of 1902 very largely relieved the Bureau of the Census from the task of obtaining technical data.[2] The special schedules of the Survey accompanied the more general Census schedule, both being prepared for every mine and quarry enumerated. There were 7 Census schedules, designated as follows:

> Special schedule No. 6. All mines and quarries must be reported on this schedule except those for which special schedules are pro-

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[1] Tenth Census, Mining Industries, Vol. XV, page xxiv.

[2] See pages 16 and 17 for memorandum concerning collaboration between the United States Geological Survey and the Bureau of the Census.

vided. Mines and quarries of the following minerals are to be reported on this schedule: Bluestone, granite, limestone, marble, sandstone, slate, trap rock, grindstones, millstones, soapstone and talc, cement rock, clay, barytes, emery and corundum, gypsum, mica, mineral paints, phosphate rock, iron ore, and manganese ore. Special attention is called to the fact that on this schedule also (special schedule No. 6) should be reported the nonargentiferous or soft lead mines located east of the Rocky mountains, the copper mines of the Lake Superior region, and zinc mines. Other minerals mined as such to be reported on this schedule, except where they accompany minerals of more importance, as platinum in gold placers, are the following: Antimony, asbestos, asphaltum, bauxite, borax, chrome ore, cobalt, feldspar, fibrous talc, flint, fluorspar, fuller's earth, garnet, graphite, infusorial earth and tripoli, magnesites, marls, molybdenum, monazite, oilstones, platinum, precious stones, pyrite, crystalline quartz, quicksilver, rutile, sulphur, tungsten, uranium, and vanadium.

Special schedule No. 8, for coal mines, both anthracite and bituminous, and anthracite coal washeries.

Special schedule No. 9, for petroleum and natural-gas wells.

Special schedule No. 10, for gold and silver and argentiferous and auriferous lead and copper mines.

Special schedule No. 11, for reduction works of the precious metals (other than smelters and refineries).

Special schedule No. 6a, a supplemental schedule for administrative and general offices. This schedule is intended for corporations, firms, or individuals operating more than one mine, quarry, or reduction works, with a central office for all of them. Upon this schedule should be reported the employees of such central office, with their salaries or wages, and all other employees whose work is not confined to one particular mine, quarry, or reduction works, such as general superintendents, machinists, surveyors, etc. All general expenses are also to be reported on this schedule and the data relating to capital stock, bonds, dividends, and assessments of incorporated companies. No data reported on this schedule should appear on the separate reports for the individual mines, quarries, or reduction works. Separate schedules are supplied for these individual plants.

Special schedule No. 6b, a supplemental schedule for bluestone, granite, limestone, marble, sandstone, slate, and trap rock quarries, upon which a full description of the quarrying and stone-dressing machines in use should be given. This schedule is to be filled out in addition to and supplementary to special schedule No. 6 for all stone quarries.

The special schedules of the Geological Survey were in the form of small cards and were provided for the following minerals:

Slate.
Marble.
Trap rock.
Granite.
Sandstone.
Bluestone.
Limestone.
Sulphuric acid.
Barytes.
Mineral paints.
Mica.
Salt.
Phosphate rock.
Gypsum.
Emery and corundum.
Millstones.
Grindstones.
Soapstone and talc.
Bituminous coal.
Anthracite coal.
Coke.
Coke, by-product plants.
Brick and tile.
Pottery.
Clay mined.
Mineral waters.
Cement.
Deep mines (precious metals).
Reduction works at mines.
Placer and surface mines (precious metals).
Local or custom mills or smelting works (precious metals).
Natural gas.
Crude petroleum.
Iron ore.
Manganese ore.
Gas, tar, and ammonia.
Precious stones.
Minor minerals (a general schedule for the production of all other minerals not included in the foregoing list).

The combination of the data contained on the Census and Geological Survey schedules makes possible the presentation of complete census statistics for the general features of the industries and also of technical information concerning each mineral. It is believed that this arrangement has resulted in the most complete and harmonious census of mines and quarries ever taken. It has made possible a separation of the purely scientific and technical inquiries from the statistical. At the same time, full information on each phase of the subject has been secured through the medium of the same agents.

Expert special agents.—At the censuses of 1850 to 1870, inclusive, the mining census was made by the United States marshals, and was incident to the enumeration of population and the collection of the statistics of agriculture and manufactures. The principal duty of the assistant marshals was the enumeration of population. The other three inquiries—agriculture, manufactures, and mining—were regarded as of much less importance, and it is probable that their importance was rated in the order named.

The first provision of law authorizing the employment of expert special agents is contained in section 18 of the act of March 3, 1879, providing for the census of 1880. This provision was reenacted in the laws providing for the Eleventh and Twelfth censuses and in the act of March 6, 1902, under which the census of that year was taken.

Persons engaged in an industry, or intimately associated with it through financial identification or through long experience in the compilation of statistical information concerning it, are in a position to select the data of greatest value and to pass upon the practicability of the schedule to be used in collecting these data. The principal advantage to statistical work from the employment of such persons is in the drafting of the schedules and analysis of the results. After the form of the schedule is determined and the inquiries thoroughly understood, the collection of the returns requires but slight, if any, technical knowledge. At the census of 1880 an attempt was made to employ experts to make the canvass,[1] but it was impossible to obtain a sufficient number of agents who had either a theoretical or practical knowledge of mining to do the work. At the census of 1890 experts and others were employed, the expert agents, as a rule, having supervision of the canvass for certain sections of the country or for certain minerals, irrespective of the location of the mines. In 1902 the schedules followed the general form used in collecting the statistics of manufacturing and mechanical industries. This was necessary in order that the totals for manufacturing and mining might be combined and the aggregate for all such industries presented. Moreover, as the technical schedules used by the Geological Survey were adopted by the Bureau of the Census, there was no necessity for the employment of experts by the Bureau in the preparation of any of the returns. The canvass was made by the regular force of the Bureau, assisted by the office and field force of the Geological Survey.

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[1] Tenth Census, Precious Metals, Vol. XIII, page xi.

Collaboration with the United States Geological Survey.—The United States Geological Survey was organized under the act of March 3, 1879, which established the office and, among other duties, provided that it should examine "the geological structure, mineral resources and products of the national domain." An act of Congress of August 7, 1882, provides that an amount not to exceed $10,000 may be annually applied by the Director of the Survey, under the direction of the Secretary of the Interior, to the procuring of statistics in relation to mines and mining other than gold and silver and to making chemical analyses of iron, coal, and oil. The first annual report of the Survey, which was transmitted to the Secretary of the Interior on November 1, 1880, covered the fiscal year ending June 30, 1880. Since then reports have been made annually, covering the calendar year.

In organizing the census of 1880, Gen. Francis A. Walker made arrangements with the Geological Survey to collect the statistics of mines and quarries.[1] Similar arrangements were made at the census of 1890.

The Geological Survey collects annually statistics of the quantity and value of production of the different minerals, in connection with its examination of the geological structure, mineral resources, and products of the national domain, and is necessarily in constant communication with mining companies, thus establishing an intimate relationship. Collaboration between the Survey and the Bureau of the Census in taking the decennial census of mines and quarries is, therefore, ideally correct, but the actual practice at earlier censuses of turning over to the employees of the Survey the entire work of collecting and compiling the census statistics resulted in a statistical presentation which was out of harmony with the presentation made in all other census industrial statistics. In other words, the mining census of 1880 was conducted on lines somewhat similar to those followed by the Survey in its annual reports, designed to show for the most part the quantity and value of the different minerals, their occurrence, an analysis of ores, and the possibility of development of the mineral resources of the country.

The report for the census of 1880 is contained in three volumes—one on the precious metals, another on nonmetalliferous minerals, and a third containing special reports on petroleum, coke, and building stones. Many of the reports are exhaustive, containing not only much statistical matter, but historical treatises and analyses as well. Uniform statistical aggregates, however, are wanting. The mining census of 1870 had proved to be so far from complete that in 1880 an effort was made to improve upon it by covering the entire field in an analytical and technical manner. Unfortunately, in doing this the necessity for a complete enumeration was lost sight of, and the inquiry was crushed by its own weight.

The United States Geological Survey had become thoroughly organized by 1890, and the mining census was taken under the direction of Dr. David T. Day, of the Survey, acting as a special agent of the Census Office. The method of presenting the statistics, however, was not in harmony with that adopted in making other census reports, and it is impossible to combine the totals of the different reports so as to show the aggregate for the mining, manufacturing, and mechanical industries of the country.

Although collaboration between different departments of the Government engaged in the same general class of work is likely to result in economy in administration, the act of Congress of March 6, 1902, provides that certain facts which differ radically from those compiled by the Survey are to be collated decennially by the Bureau of the Census. In order to compile these data and insure their harmony with other census reports, it is necessary that the Bureau of the Census have absolute control of both the canvass and the office work. Prior to the census of 1902, however, it was contended by the Survey that statistical conditions existed in the work of that office similar to those at the Bureau of the Census, and that if the statistics for the annual report on "Mineral Resources" were to be taken in collaboration with the census of mines and quarries, the fieldwork and the preliminary examination of the census schedules should be under the supervision of the Survey. It was therefore impossible to make arrangements that would be entirely satisfactory to both offices. The methods followed at the censuses of 1880 and 1890 having proved entirely inadequate, however, the following memorandum was agreed upon as the working basis of the two offices for the census of 1902:

Memorandum of agreement between the Director of the United States Geological Survey and the Director of the United States Census regarding the cooperation of the two offices in taking the mining census of 1902.

For the purpose of avoiding a duplicate canvass of the mining industry as provided for by the laws relating to the Geological Survey and the Census Office, of saving an unnecessary expenditure which would arise from such simultaneous duplication of the canvass, and to insure harmony between the statistics of the Geological Survey and of the Census Office, the following agreement has been reached:

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[1] In 1879 Prof. Ralph Pumpelly, head of the Division of Mines and Geology, United States Geological Survey, and the force working under him, were detailed to act as special agents of the Census Office to collect and discuss the statistics of the mining industries of the United States, exclusive of the precious metals. A report on the statistics and technology of the precious metals was prepared under the direction of Hon. Clarence King, Director of the Geological Survey, and the report on the production, technology, and uses of petroleum and its products was prepared by Mr. S. F. Peckham; on the manufacture of coke, by Mr. Joseph D. Weeks; and on building stones and the quarry industry, by Dr. George W. Hawes and others.

I. The Geological Survey to take the general supervision of the fieldwork for the mining census, transmitting the several schedules of the Census Office to the producers in the same envelope with its own schedule and receiving them back in its own penalty envelopes; the Census schedules thus obtained by the Geological Survey to be transmitted to the Census Office as rapidly as received for examination and correction; such of the Census schedules as may require additional fieldwork to perfect them to be returned to the Geological Survey, at the discretion of the Census Office, in order that the desired corrections may be obtained. The clerical expense of handling the schedules and the correspondence connected therewith to be borne by the Geological Survey, but with the understanding that whenever more clerks are required than can be spared from the regular force of the Geological Survey the Census Office will detail such additional clerks from its regular force and will continue to carry them upon its pay rolls. All the work of tabulating and compiling the Census schedules to be done in the Census Office by the Census Office clerks. The Census Office to have the privilege of transcribing from the schedules of the Geological Survey such additional information contained therein as may be omitted from its own schedules for the purpose of greater simplicity.

II. The fieldwork which may be necessary in addition to correspondence in order to secure an early return for the mining census shall be done by the present force of trained experts—some 25 in number—employed by the Geological Survey in its regular fieldwork; and such additional clerks as may be required to complete the fieldwork with all possible rapidity shall be drawn from the regular clerical force of the Census Office.

III. The Geological Survey will contribute toward the expense of this fieldwork from its regular appropriation a sum equal to its annual expenditure for this purpose in previous years, the entire remainder of the cost of the fieldwork to be borne by the Census Office. This will involve, in many instances, a temporary transfer of the field agents of the Geological Survey from the rolls of that office to the rolls of the Census Office, this transfer to be made in every instance at the rates of compensation which they are receiving from the Geological Survey. The allowance for per diem expenses to be the same in every case as the Census allowance for its own field agents. The fieldwork for the mining census in 1890, as shown by the records of the Census Office, cost $142,113.47, being the amount paid to the maximum number of special agents employed, namely, 228.

IV. A representative of the Census Office to be detailed to act as assistant to the statistical division of the Geological Survey during the progress of the fieldwork. This is necessary in order that the Census Office may have a properly trained expert in its own clerical force thoroughly cognizant of all the details of the work, and thus qualified to oversee the tabulation and compilation of the Census statistics.

V. Whenever it may be so desired the Census Office to have the privilege of calling upon the experts of the Geological Survey to prepare the texts of its reports on the several branches of the mining industry.

VI. The schedules of the Census inquiry to be prepared and ready for delivery to the Geological Survey not later than January 1, 1903.

VII. The schedules to be thus handled by the Geological Survey to include all the mining schedules issued by the Census Office, including those for gold, silver, and stone quarrying.

The schedules of the Bureau of the Census and of the Geological Survey were mailed by the latter office to all mines and quarries known to be in existence, the letter of transmittal being signed by the directors of both offices.[1] The schedules were returned to the Survey and there given a cursory examination, the amounts reported in the schedules for the two offices being compared and the schedules separated. The schedules for the Census were then forwarded to the Bureau of the Census. This method, though it simplified the office work, multiplied the difficulties of the canvass. Each mine operator was required to prepare two schedules, a number of the questions on the two being similar. A large number of operators prepared the Survey schedule in conformity with their annual practice, but neglected the Census schedule. In a number of instances the Survey schedule required the quantity and value of the mineral marketed, while the Census schedule called for the quantity produced during the year. In other cases the Survey schedule required a report of the finished manufactured product, while the Census schedule called for the quantity and value of the crude ore.

It was often impossible to obtain a proper adjustment of these differences by correspondence, and in

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[1] Department of the Interior,
United States Geological Survey,
Washington, D. C., December 31, 1902.

Dear Sir: In accordance with an agreement between the Director of the Census and the Director of the United States Geological Survey, as shown in the subjoined letter, this Office will collect the data for the mining census in addition to the usual information collected annually for the report Mineral Resources. I therefore inclose herewith a copy of the census schedule, together with the card of this Office, with the request that you fill them both out and return them at the earliest possible moment. An addressed envelope, requiring no postage, is inclosed for reply.

Please answer every question in both schedules. All information furnished will be held strictly confidential. Only state, county, or district totals will be published. All Census employees are subject to a heavy fine for revealing information obtained for census purposes.

Your especial attention is called to the fact that the inquiry in regard to labor and wages is intended to include all the labor expended upon the product up to the time the material leaves the establishment, including grinding, washing, or other treatment.

Trusting that you will give this matter your prompt and careful attention, and thanking you in advance for your courtesy, I am,
Yours, very truly,
Chas. D. Walcott, *Director.*

Census Office,
Washington, D. C., November 17, 1902.

Hon. Charles D. Walcott, *Director,*
United States Geological Survey, Washington, D. C.

Sir: In accordance with our understanding, you are hereby authorized to collect for the Census Office the schedules relating to the mines and mining industry required by section 7 of the act of Congress to create a permanent Census Office, approved March 6, 1902, at the same time and by the same methods employed in the collection of the annual mining statistics of the United States Geological Survey. This course will be in the interests of economy and efficiency, and will also save the producers the necessity of making out two schedules, at different times, which are in some respects duplicates of each other.

In transmitting the Census schedules to the producers and mine owners you are authorized to assure them that all information received on the Census schedules will be treated as strictly confidential and no publication will be made which will reveal the business or the operations of any individual, firm, or corporation in any branch of the mining or quarrying industry.

Very respectfully,
William R. Merriam,
Director of the Census.

many cases the special agents found it difficult even by personal investigation to make a satisfactory explanation and to secure harmonious reports for the two offices. Many of these difficulties would have been obviated had the plan been tried of using a single schedule containing all of the inquiries needed for both offices. This, however, was believed to be impracticable, since considerable detail was required by the different reports.

The Census schedules contained inquiries concerning capital, employees, wages, daily rates of pay, materials, miscellaneous expenses, etc., as well as the quantity and value of the product. Under the conditions stated it would appear logical to have had the canvass made under the direct supervision of the Bureau of the Census, and to have included in the Census schedules the few additional inquiries as to finished product or products sold that are required for the annual report of the Survey. Such an arrangement would have required but one schedule for each producer.

III.

DIFFICULTIES AND DEFECTS OF THE ENUMERATION.

The claim is not made for the mining census of 1902 that a complete canvass has been possible, or that the figures presented are the result of an actual enumeration of all mines and quarries in operation during the period covered. The reports for the census of 1870 direct particular attention to the incompleteness of the statistics for 1860 and 1870. The reasons for the incompleteness of the statistics at the census of 1880, so far as they relate to precious metals, are given as follows:

> 1. From want of previous experience, the agents in charge could not distribute equally the ground to be covered among the experts employed, since the number of mines to be investigated bore no necessary relation to geographical area. As a consequence, toward the end of the time devoted to the investigation some regions received less attention than their relative importance merited.
>
> 2. The relative ability of the experts employed was necessarily unknown to the agents in charge until the investigation had proceeded so far that it was too late to make any radical change.
>
> 3. It was a practical impossibility to secure uniformity of ability and methods among so large a corps of experts as was necessary for the work. The result was that one would give more attention to one class of facts, another to another class, and, when totals were made up from the schedule returns, it was found that these facts were more complete in one region than another.

The lack of uniformity in the statistics for the different minerals has been referred to above under the title of "Development of mining statistics." It is impossible to determine the extent to which the production of minerals and ores by small operators was omitted from the reports for that census. Special attention appears to have been given to the small operators, and reports were secured from 9,969 small coal mines, classed as "Local mines and farmers' banks," in which coal was produced at irregular intervals. In referring to the incompleteness of the statistics for gold and silver in the report of the same census, it is stated that it was impossible to locate a vast number of independent miners producing gold in small quantities, often in remote and almost inaccessible spots; also that "while the average annual production of these prospectors or miners is small, the aggregate amount is considerable; but no full or accurate statistics of this portion of gold production can be obtained."

The census of 1902 does not contain reports from a number of the irregular producers and small mines. This is especially true of the small placer gold mines, irregular bituminous coal producers, and small lime and sandstone quarries. Schedules were mailed to every mine and quarry of which the name and address could be obtained, and in every case where a satisfactory schedule was not received by mail one was secured by a special agent. The special agents visited every section of the country and made diligent inquiry for mines and quarries not named on their official lists; every known source of information was exhausted in the preparation of these lists. It is believed, therefore, that the statistics are the results of as complete an enumeration as it is practicable to make. It is not contended that reports were secured from all mines and quarries, but that a large proportion of them have been reported is shown by the fact that returns were received for 5,345 operators of mines, quarries, and wells that reported an annual product valued at less than $500. In bituminous coal there were 798 producers of this class, and in limestone 1,296. For gold and silver, 3,252 reports were received for operators engaged in development work only, and 1,196 that reported a product valued at less than $1,000. The enumeration, however, did not extend to mining claims, although reports were received from 5,511 of such claims on which, in order to comply with the law and hold the claim, at least $100 worth of work was done during the year. The agents were instructed to omit from the enumeration the small placer gold mines at which less than two wage-earners were employed, unless such mines were in close proximity to other mines being enumerated. The value of the gold produced by the small placer miners and irregular operators is estimated at $1,633,835. This value is included as a separate item in the production for the United States, but there are no statistics concerning the number of people employed or the cost of materials and supplies.

In previous censuses all mines that did not report a production valued at $500 or more were usually omitted from the reports. This rule, if strictly followed, would exclude a large number of important properties, for some important mines are operated to only a limited extent, the major portion of the work being devoted to development. Therefore, no limit of this character was made at this census. It is admitted, nevertheless, that considerable quantities of mineral mined by farmers, ranchmen, contractors, and others were not accounted for, because these men were not known as miners or quarrymen, and were overlooked by the agents. This kind of mining is carried on at irregular intervals, no record is kept of the production, and there are no available statistics concerning operations.

During the year 1902 the production of bituminous coal by irregular operators was greatly stimulated by the curtailment of the supply of anthracite coal. A large number of farmers worked their coal banks with farm labor whenever other duties would permit. Every means was exhausted to obtain the names and addresses of these producers, and a small schedule was sent to all whose names could be secured.[1] The report contains the statistics for 4,409 bituminous coal producers, and of this number 825 were reported on the small schedule as irregular operators. When the small schedule showed a production of 500 tons the regular schedule was sent and a full report as to employees, wages, etc., secured.

The nature of the work of the small, irregular operators precludes the possibility of a complete enumeration, nor is it essential for a mining census that returns be secured from all farmers and others who produced a few tons of mineral during the year, a large proportion of which was probably consumed in the local market. The reports for such small mines show, as a rule, only the quantity and value of the production. Most of the labor is done by the owner, and the expense for materials and supplies is so small that it is not reported.

In the mining of lead and zinc ore in Missouri, and in the mining of monazite, mica, and other minerals found in small quantities in different localities, it is the practice of the small producer to devote odd times to mining. In some cases the mining is done by a farmer on his own land; in other cases it is done on leased land or under a royalty agreement. In the majority of cases the ore is sold to one or more of the large establishments in the immediate vicinity, where it is reduced, refined, or prepared in some manner for the market. Under these conditions it is very difficult to obtain reports from the producers.

The census of zinc-lead mining in Missouri and Kansas presented peculiar difficulties, because of the method of the organization of this industry in that district. Only a few of the larger properties are operated by the owners. Nearly all of these properties are divided into tracts and leased to individuals or companies, who again divide them into small plots of an acre or less and sublease them to operators. In some cases this system of subleasing is carried still further. The actual operators are frequently practical miners, who work with pick and shovel. As the earnings of such operators are dependent upon the run of the ore, the mine is abandoned by the sublessee as soon as the returns prove unsatisfactory. A shaft is thus worked intermittently, a few weeks by one operator, then a few weeks by another, often changing hands several times during the year. The operators are constantly moving from one place to another. Those found on the properties by the Census agents in 1903 were only too often new operators, who had not been connected with the mines during the year 1902, for which information was sought, while those who had operated them in 1902 had moved away and could not be located. In such cases the only information available was that which could be furnished by the landowner. This information was naturally confined to the quantity and value of the product of the entire property; if the property was owned by a large company, its books, at best, might show the quantity and value of product of each of the first lessees. No further census data could be obtained.

The figures of production furnished by the owners, while correct in themselves, because taken from their books, presented still other difficulties, when treated in connection with other reports. A typical case could be described as follows: A report was secured from the owner covering the production of his entire property, with the exception, perhaps, of one tract leased to a large corporation, which furnished its own report. A few similar reports were received from first lessees of the owner, some of whom were active operators and some were sublessees. One or two of the sublessees could be located, and these furnished reports substantially accurate, although mostly from memory. Other first lessees could not be found or had transferred their leases to new holders, but some of their sublessees remained on the property and furnished reports to the census agent.

In order to avoid duplications, it was necessary to compare all these reports, and to subtract from the owner's report that which was reported by his first lessees and the sublessees. When it was attempted to balance the figures it appeared that the results could not be made to agree; for example, the sublessees showed a larger quantity of lead and zinc than that reported by the first lessee, while the value was considerably less than that reported by the owner. The explanation lay in the fact that part of the ore was sold in rough state by the sublessees to the owner, who concentrated it at his mill and disposed of it at a higher price. An inquiry addressed to one of the leading companies of the district brought the reply that the records of the company could not be adjusted to meet the figures furnished by the operators. The letter concluded by saying: "If it is your intention to reconcile their figures with those furnished from this office, we think you will have a hopeless and never ending task." Some of these discrepancies could be and were corrected at this office. If the value of zinc ore was reported by one operator at something like $3 per ton, whereas the average value reported by the owner and other operators on his property was about $30 per ton, it was safe to infer that the former represented rough ore and the latter dressed ore; if, on the contrary, the report showed that the lessee operated a concentrating mill in connection with his leased mine, the unusually low price of the ore would indicate a low percentage of zinc in the dressed ore. In the former case a substantial agreement between the conflicting figures could be attained by reducing the quantity of rough ore to terms of dressed ore, taking as a basis the average price per ton of dressed ore; in the latter case the quantity could not be disturbed. It is of course obvious that omissions and duplications could not be avoided. Still the census figures for the value of zinc and lead mined in the state of Missouri, which yields the bulk of the product, substantially agree with the returns secured, independently of the Bureau of the Census, by the state lead and zinc mines inspector.

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[1] See Appendix A

The conditions prevailing in the region precluded anything like a complete and accurate presentation of all the labor employed in the mines. Aside from the numerous class of small operators who themselves work in the mines and are helped by members of their own family, or perhaps by one or two hired men, many of the operators who work the mines with none but hired labor frequently keep no books whatsoever. They may be able to state with substantial accuracy the number of men employed during the year and, by computation from the average rates paid by them, the amount expended for wages; but the items of "supplies" and "miscellaneous expenses" are in such cases nothing but rough estimates, and the accuracy of the results can not be vouched for. There is a large class of mines in which no miners are hired either by the day or by the ton, all mining labor being done on shares by "lessees," so called, who agree to pay the operator a stipulated royalty on all ore mined. In most cases of this class no records of the number of such lessees were kept by the operators, who could furnish no information beyond the total quantity and value of ore mined and the royalty received. Whenever practicable the number of men working on shares was secured from the landowner. The proceeds from the sale of the ore, less the royalty received by the landowner, represent the gross earnings of the miners, who are required to buy their own mine supplies. The number of such miners with their gross earnings, as far as reported, is shown separately, but is not included among regular wage-earners.

In the monazite industry the production is controlled by a single establishment, the product of a number of operators being purchased by one company, from which a complete report was secured. It was impossible to obtain reports from the small independent miners, but the number of such operators was known by the company and they were included as its employees. It was considered that the ore was mined on a contract basis, and the amount paid for it, or a proper proportion of such amount, was credited as wages.

The conditions under which mica is mined are somewhat similar to those prevailing in the monazite industry. Returns were secured from a number of the small independent producers, but a considerable proportion of the production could not be covered by such reports and was accounted for only in the schedules of the large establishments where it was prepared for the market.

There were only 17 regularly worked mines reported for the production of precious stones. Many of the precious stones were obtained by incidental discoveries or systematic search. The number of people engaged in this irregular work and the value of the stones are largely estimates based on information obtained from merchants and others familiar with local conditions.

In addition to the difficulties and the possibilities of error attending the collection of statistics of minerals for which the mining operations were similar to those enumerated above, there are uncertainties in connection with the collection of the reports and compiling the statistics for minerals mined by large and well organized companies. For instance, the schedule required the value of the product f. o. b. at the mine or quarry. A number of the anthracite coal companies contended that it was impossible to give such a value, or, in fact, any value for their product, since a portion was consumed at the mines in connection with their operation, considerable quantities were sold in the local market, and an unknown quantity was sold at a loss; also, that it was impracticable to deduct, or, in fact, to ascertain, the freight charges. The values are therefore largely estimated, based on the average value per ton of coal at the mine, the results being compared and checked with every available source of information. The production of petroleum is largely in the control of the Standard Oil Company, which contended that it was impossible to obtain separate reports from the individual producers. The company made one report covering the operations of 9,806 producers of oil in 39,301 oil wells in Pennsylvania, also similar combined reports for 2,123 producers and 8,443 wells in New York, 9,997 producers and 42,469 wells in Ohio, 4,435 producers and 12,951 wells in West Virginia. There were in all 7 schedules received from the company, which contained the statistics for 28,925 producers and 112,794 wells. In addition to the reports of the Standard Oil Company, there were 604 schedules received from 597 producers covering the operations of 5,877 wells. The 7 schedules from the Standard Oil Company covered 98 per cent of the producers and 95 per cent of the wells reported for the United States. Similar reports were made by the company for its production of natural gas, 4 schedules being received for 19 producers and 1,701 wells in Pennsylvania, New York, Ohio, and West Virginia, the producers forming 1 per cent and the wells 10.8 per cent of the total for the United States. Under these conditions it was impossible to localize the statistics for petroleum and natural gas by counties or to check or verify the estimates of the number of employees, wages, expenses, etc. The schedules were carefully prepared and evidently cover the entire production of all the wells. The conditions under which the statistics have been compiled are in some respects similar to those prevailing in the mining of lead, zinc, mica, and monazite, in that the production is sold to one or more large establishments that put it on the market and thus in a measure control the output.

Since the recent discoveries of rich placer deposits have given prominence to the gold fields of Alaska, efforts have been made by the Government to obtain statistics by direct communication with the numerous owners of those mines. Mr. Charles G. Yale, special agent of the Bureau of the Mint, reported the following for the calendar year 1899:

> The population of these camps is more or less nomadic, moving from place to place as strikes in new creeks are announced. The season of mail communication among the camps along the Yukon river and creeks is very short, and when the spring "clean ups" have been made or the summer diggings begin to freeze the men come "outside" for the winter or go to larger camps. For these reasons it is almost impossible to obtain the desired statistical information as to the output of gold by correspondence with the individual miners.[1]

Dr. Cabell Whitehead, formerly assayer of the Mint, reported as follows from Nome, under date of September 5, 1900:

> Many men are prospecting throughout the entire country and we can only tell what they produce when they come in, as they are very secretive in all matters concerning their productions.[2]

The same was the experience of the agent of the Department of Labor, who investigated on the spot the conditions of Alaska gold mining. The difficulties in obtaining statistics of the placer mines in Alaska may be judged from the number of claims recorded, which in the Nome district alone had, up to January 10, 1900, reached 4,500.[3] This number is largely in excess of the total number of producing properties embraced in the present census of gold and silver mines for all states and territories. Important as it may be to ascertain the exact conditions under which an individual miner can nowadays produce gold without any capital, practically with his own hands, it was thought that this could be most successfully done in connection with the general census of population and occupations, whereas it could not be accomplished without an extraordinary expenditure of time and money as a part of the census confined to mines and mining. The quantity and value of the output of the Alaska gold mines are reproduced in this report from the report of the Director of the Mint, whose estimates are based upon the returns from the mints, assay offices, and from private refineries.

Porto Rico was the only insular possession in which the mineral resources were deemed of sufficient importance to attempt an enumeration. While it is known that a variety of minerals exist in the island, very few, if any, mines and quarries were operated as a regular business during the year 1902. The work was done at odd times and only sufficient material extracted to satisfy the local demand. It was difficult to locate the properties that had been worked, and practically impossible to obtain any information concerning the number of people employed or the quantity and value of the product. Under these conditions the statistics for the island are not comparable with those compiled for continental United States, and no reference is made to them in the general tables. The report on the mineral industries of Porto Rico consists principally of a compilation of historical data, a statement of the mining laws, and a list of the mineral deposits, with such information as could be obtained concerning the quantity and value of the products.

The omission of the small producers and the impossibility of obtaining individual reports from certain other producers, the data being included in a combined schedule, are the principal sources of error in the canvass. Another source of error is inherent in the preparation of the reports. A comparatively small proportion of the reports were prepared from data obtained from account books; but those which were prepared from such accounts were, as a rule, for the important operators and represented a large proportion of the production. The data in many of the schedules are estimates based on the recollection of the person answering the inquiries. This is particularly true of the answers to such inquiries as "The average number of wage-earners employed during each month" and "The average number of wage-earners at specified daily rates of pay." Few establishments keep books from which answers to inquiries of this character, covering a period of twelve months, could be readily obtained. If the information was obtained from the account books, it required an examination of a number of books and a large number of entries. The principal anthracite coal companies gave the office permission to examine their account books and compile the totals required for an answer to each inquiry. Two clerks were detailed to New York, N. Y., and Scranton, Pa., for this work. The method of keeping the pay rolls of the anthracite coal companies, from which was obtained the average number of persons employed by them during the year and the amount of wages paid, differs but slightly with the different companies. The original pay rolls are in sheet form, but by most companies are copied into books, these books being retained for office reference and the originals placed in vaults at the general offices of the companies or in storage. The census data were obtained from the office copies. The pay rolls are made out semimonthly. The names of the employees are written twice each month by some of the companies, while others arrange their books so that both the first and last halves of each month are carried on the same set of sheets. The greater number of the companies keep their wage accounts "by collieries," having for each colliery a separate book in which are shown all the operations of that colliery during the year. Other companies keep these accounts "by months," having for each month a separate book in which are shown the operations of all their collieries for that one month. Usually the classes of employees were listed on the pay rolls in nearly the same order as they are shown in the census schedule, the list being headed by foremen, followed by clerks and the various classes as indicated; usually the employees above ground and those below ground are listed separately and designated as "outside" and "inside," respectively. Few, if any, of the companies distinguish on their pay rolls between boys under 16 years of age and employees over that age, and the records of none of the companies show the number of boys under 16 years of age in their employ. The average number of wage-earners employed during the year by these companies was obtained in all cases by first averaging each semimonthly sheet of the pay roll separately, adding together these sheet averages to obtain the average for the month, and finally dividing the sum of the monthly averages by 12 to show the average number employed during the year. The averaging of the number of wage-earners by sheets was accomplished by different methods. In some cases the number of men employed and the hours of labor were so uniform throughout the month that the number of names shown on the roll was used as the monthly average. As the rolls were usually headed by foremen, clerks, etc., the average numbers in these classes were easily obtained, and the deduction of these averages from the sheet average would show the average number of other employees; but in many cases where conditions were not uniform throughout the month, the sheet average was obtained by multiplying the number of employees on each sheet by the number of days in operation and dividing the product by the number of working days in the month, usually 25, 26, or 27 days. The sum of the sheet averages gave practically, but not exactly, the average for the month. To have obtained an exact average would have necessitated the addition of the total number of hours worked by each man during the month, the division of this aggregate by the number of hours fixed upon as constituting a day's labor, and the division of the quotient thus obtained by the number of working days in the month. From such monthly averages an exact yearly average could be obtained.

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[1] Report of the Director of the Mint upon the Production of the Precious Metals during the calendar year 1899, page 51.

[2] Ibid., 1900, page 56.

[3] Bulletin of the Department of Labor, 1900, "The Yukon and Nome Gold Regions," page 861.

As no company keeps a record of the aggregate number of hours of labor performed each month, the length of time which would have been required to obtain the averages by this method would have caused too great a delay in the publication of the report. The two methods first mentioned gave sufficiently accurate averages for the months in which regular forces were employed throughout. It was found necessary, however, to adopt the latter method to obtain the average for those months during the strike when the number of employees was constantly varying.

While there were comparatively few operators for whom the preparation of the Census reports was attended with so many difficulties, still it is evident that the data furnished in reply to the majority of the inquiries were not obtained from the account books. It is probable that the percentage of error due to the fact that the answers are based on memory or rough memoranda, and not on actual records—a condition incident to all census work—is greater in the mining census than in any other branch of the industrial census.

IV.

OFFICE AND FIELD WORK.

The most important feature of the preliminary work of the mining census was the preparation of the schedules and instructions.[1] This work was started in November, 1902, and the last installment of the schedules was received from the Government Printing Office about the last of January, 1903. In the meantime the mailing of the schedules to the mine operators had been in progress and was completed shortly after the 1st of February, 1903. The mailing of the schedules and the general supervision of the fieldwork was under the direction of the Geological Survey. The theory of the work was that the schedules, instructions, and all circulars necessary for the canvass should be prepared at the Bureau of the Census and placed at the disposal of the Geological Survey for transmission to the field force. As the schedules were received, either by mail direct from the operators or from the special agents, they were immediately turned over to the Bureau of the Census for examination, all defective schedules being returned to the Survey for correction. The Survey schedule accompanied the Census schedule, and the quantity and value of the products reported on both were made to agree before they were separated. The Survey schedule was frequently filled and returned through the mail without the Census report, which was neglected until the field agent called. This neglect and the necessity for returning a large proportion of the Census schedules for correction resulted in the separation of the schedules in such a large number of cases that a general comparison of the final tabulations was necessary to insure an agreement between the two offices.

The schedules for bituminous coal, clay, stone, gypsum, cement, and fuller's earth were the only ones mailed directly to the mines from the Washington office of the Survey. All of the other schedules were sent in bulk to the offices of the field assistants of the Survey and mailed from there to the operators. About three weeks were allowed for the return of the schedules by mail. The entire United States was then divided into districts, and the actual canvass was started on or about January 15, 1903, but at this time of the year some sections of the country are inaccessible, and it was impossible to employ the maximum field force until May, 1903, when there were 113 agents and clerks at work in the field or in the offices of the supervisory agents in different sections of the country. This number does not include the agents and clerks on the rolls of the Geological Survey who were engaged in collecting reports or other work incident to the canvass. The schedules were therefore returned by the mining company to the local office of the field assistant, given a preliminary examination there, then forwarded to the Geological Survey, where they were again examined before being sent to the Bureau of the Census. The final examination was made at the office of the Bureau, and letters criticising the schedules or calling for additional information were forwarded to the Geological Survey, and from there sent to the field assistant, who transmitted them to the mine operators by mail or through a personal visit of a field agent, or obtained the information personally, and again returned the schedules to the Geological Survey for transmittal to the Bureau. The practice of dividing the country into districts and placing the work in each district under the supervision of a local official is the most efficient way to conduct a canvass, but it is evident that these methods when followed in the mining census must lead to a duplication of work and more or less confusion, especially when schedules are being received not only from field agents who visit the mines, but also from the operators themselves.

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[1] For copy of schedules see Appendix A, and for instructions see Appendix B.

The fieldwork of a mining census is necessarily based on lists giving the names and addresses of mines and quarries. The preparation of a complete list is therefore a very important part of the office work. The lists used for the census of 1902 were prepared in the division of mining and mineral resources of the United States Geological Survey, and are the outgrowth of the annual reports of that division on the mineral products of the country. The annual returns secured from the mines and quarries for these reports are of assistance in revising the lists at regular intervals. The names and location of new developments are obtained from technical journals and periodicals. All publications of this character are examined and notices of new mining enterprises are clipped. New producers are corresponded with to ascertain the full name, address, location of mine, and character of mineral. Confidential copies of the completed lists are sent at regular intervals to representative producers in different sections of the country for revision and the addition of new names. One of the principal advantages of the collaboration between the Geological Survey and the Bureau of the Census was the utilization of this list.

The special agents were instructed to supplement the official lists by careful inquiries in each locality visited, and to obtain reports from all mines that were in operation during any portion of the year. Two classes were excepted from these instructions; one was the small placer gold mine operators and the other the irregular bituminous coal miners. It is impossible to locate the small placer miners. Moreover, the only statistical information that could be obtained would be the quantity and value of their product, which can be estimated or secured from other sources equally reliable. Therefore no effort was made to secure reports from mines of this class unless the agent was in the vicinity in connection with other work and the preparation of the reports for the small mine would cause no delay. The reports for the irregular bituminous coal producers were obtained by correspondence.

Next to the schedule itself, the instructions for its uniform application are of the greatest importance. Such instructions were prepared and distributed to the special agents before they entered on duty. These instructions were of a general and special character; they defined the agents' duties and described the practices to be followed in securing schedules. They were used in connection with the instructions printed on each schedule, and were followed in the preparation of all reports.

The office work on the mining census was in progress from November, 1902, to July, 1904. During the greater part of this time comparatively few clerks were employed. The greatest number, 91, was reached on October 25, 1903, when the tabulation was at its height. The cost of the office work paid for by the Bureau of the Census was $77,853.17, and of the fieldwork $98,019.78, thus making the total cost of the mining census, exclusive of the final revision of the manuscript and printing and binding, $175,872.95. The schedules for the annual report of the Geological Survey were secured in connection with those for the Bureau of the Census, and the expenditure covers the collection of schedules for the reports of both offices. In some industries omitted from the mining census, but included in the annual reports of the Survey, such as the manufacture of gas, brick, pottery, etc., schedules were collected by the Census agents and turned over to the Survey. On the other hand, considerable Census work was done by the regular employees of the Geological Survey and at the expense of that office.

After the completion of the fieldwork several of the expert special agents employed by the United States Geological Survey in the preparation of the annual reports on Mineral Resources of the United States were retained by the Bureau of the Census to prepare the historical and descriptive text which accompanies the statistics for the principal minerals. These special agents and the minerals assigned to each are as follows:

Dr. David T. Day	Platinum and iridium.
Dr. Joseph Struthers	Asphaltum and bituminous rock. Bauxite. Borax. Graphite. Magnesite. Mineral pigments, crude. Phosphate rock. Quicksilver. Sulphur and pyrite.
Dr. Joseph Hyde Pratt	Abrasive materials: Buhrstones and millstones. Crystalline quartz. Corundum and emery. Garnet. Grindstones and pulpstones. Infusorial earth, tripoli, and pumice. Oilstones, whetstones, and scythestones. Asbestos. Fluorspar. Lithium ore. Monazite. Talc and soapstone. Barytes. Mica. Steel hardening metals: Chrome ore. Nickel and cobalt. Molybdenum. Rutile. Tungsten. Uranium and vanadium.
Mr. George F. Kunz	Precious stones.
Mr. John Birkinbine	Iron ore. Manganese ore.
Mr. E. W. Parker	Coal, anthracite. Coal, bituminous.
Mr. Jefferson Middleton	Clay.
Mr. F. H. Oliphant	Petroleum and natural gas.

In addition to the above the text for certain minerals was prepared by experts, as follows:

Dr. George P. Merrill	Limestones and dolomites. Marble. Sandstones and quartzites. Silica sand. Siliceous crystalline rocks. Slate.
Dr. I. A. Hourwich	Gold and silver. Copper ore. Lead and zinc ore.
Mr. Story B. Ladd	Cement. Feldspar. Flint. Fuller's earth. Gypsum. Marl.

As previously explained, the schedules were mailed to all mines and quarries. There were received in all 38,151 schedules. Of this number 28,569 were for productive and 7,193 for unproductive and idle properties. In addition there were 2,389 schedules for mines and quarries that were abandoned, and therefore omitted from the tabulation. While comparatively few complete schedules were received through the mail for active properties, the mailing of the blanks was of great assistance to the fieldwork in disposing of the names of idle and abandoned mines and avoiding the necessity of visits by agents. The fieldwork was in progress from about January 15, 1903, to February 1, 1904. The total cost of the fieldwork, as paid for by the Bureau of the Census, was $98,019.78, which included $13,061.10 paid to supervising agents and their assistants who did no traveling. There were in all 122 different individuals, agents, and clerks engaged in the field, but of this number 39 were in a supervising capacity or employed in the offices of supervising agents and did no traveling. There were 83 persons engaged in the collection of schedules, the maximum number, 72, being at work in May, 1903.

As the special agents collected schedules from all mines and quarries in the localities visited, irrespective of the character of the mineral, the cost of the fieldwork for a specific mineral can not be computed with exactness, but the average cost per schedule for the active properties, both productive and unproductive, was about $3. Using this average, the following statement shows the approximate cost of the fieldwork for the principal minerals:

MINERAL.	Cost of fieldwork.
Total	$98,019.78
Bituminous coal	14,123.40
Anthracite coal	944.39
Iron	1,570.98
Gold and silver	47,815.13
Copper	509.67
Lead and zinc	2,974.04
Stone (all varieties)	16,842.78
All other minerals	12,989.39

V.

CLASSIFICATION OF MINERALS.

The statistics are presented in 52 classifications, each comprising the total for a distinct mineral or group of minerals. In some cases minerals or ores yielding two or more products were obtained from the same mine or quarry, and it was impracticable to separate the employees, wages, and expenses incident to the production of each. For instance, if the ore from a mine yielded both silver and copper, the latter being of the greater value, the report was assigned to copper, and all the employees, wages, and expenses were included in the totals for that mineral. If the chief product of a quarry was sandstone the report was classified as "sandstones and quartzites," though some of the product may have been manufactured into and sold as grindstones and pulpstones. In order to avoid duplication and, at the same time, show the total production for each classification, the by-products, when they formed the finished product of the mine or quarry, were added to the classification of which they formed a part. The following statement gives the quantity and value of the by-products that it was possible to segregate, the names of the classifications to which they were added, and the classification under which the employees, wages, and expenses incident to their production are included:

BY-PRODUCT.	PRODUCTION.			Classification to which by-product should be added to obtain a total that is comparable with employees, wages, and expenses.
	Quantity.		Value.	
	Unit of measure.	Amount.		
Barytes	Short tons.	539	$1,618	Lead and zinc ore.
Buhrstones and millstones.	Stones	100	1,125	Siliceous crystalline rocks.
Cement			13,149	Limestones and dolomites.
Clay			400	Limestones and dolomites.
Feldspar	Short tons.	112	1,000	Flint.
Flint	Short tons.	1,254	2,593	Feldspar.
Grindstones and pulpstones.	Short tons.	35,503	403,006	Sandstones and quartzites
Infusorial earth, tripoli, and pumice.	Short tons.	175	1,436	Talc and soapstone.
Lead and zinc ore	Pounds	1,625,813	37,212	Barytes.
Limestones and dolomites.			386	Coal, bituminous.
Limestones and dolomites.			124,687	Cement.
Limestones and dolomites.			5,100	Sandstones and quartzites.
Marble			8,133	Limestones and dolomites.
Mineral pigments, crude.			325	Slate.
Natural gas			103,112	Petroleum.
Oilstones, whetstones, and scythestones.	Short tons.	180	8,872	Sandstones and quartzites.
Oilstones, whetstones, and scythestones.	Short tons.	595	29,740	Grindstones and pulpstones.
Petroleum	Barrels	1,520	1,370	Natural gas.
Sandstones and quartzites.			1,273	Limestones and dolomites.
Sandstones and quartzites.			510	Grindstones and pulpstones.
Silica sand			50,811	Sandstones and quartzites
Sulphur and pyrite	Long tons.	11,483	29,420	Coal, bituminous.

As shown by this statement, there are 18 of the classifications of minerals for which the values are increased by the inclusion of products obtained in connection with products included under other classifications. For instance, the total production of barytes amounted to 61,668 short tons, valued at $203,154. This includes 539 short tons, valued at $1,618, obtained as a by-product from lead and zinc mines. The employees, wages, and other expenses incident to the production of this by-product are included in the totals for lead and zinc ore. On the other hand, the production of lead and zinc was valued at $14,600,177, which includes 1,625,813 pounds, valued at $37,212, obtained as a by-product from the mining of barytes, the employees, wages, and expenses incident to the production of this by-product being included in the statistics for barytes. In other words, the products of certain mines were segregated so as to show the total production for a given mineral, irrespective of the class of mines from which it was obtained. This practice is in harmony with the methods of the United States Geological Survey, and the reason for its adoption was to obtain totals which would agree with the totals of that office. This method has been followed consistently in the statistics for all minerals except for argentiferous ores. Such a large percentage of silver, copper, lead, and zinc is obtained from the same ores that it was impracticable to segregate their values, and at the same time to present products which would be in any degree comparable for employees, wages, and expenses incident to their production. The totals for these minerals, therefore, present all of the statistics for the mines included in each classification. In treating the different ores, however, the production has been segregated so as to show the total for each metal.

While the theoretical accuracy of this method of tabulating the reports may be disputed, for the reason that it has resulted in assigning to some minerals a larger number of employees and a greater expense than are incident to their production, it is the only practicable way of presenting the data. It permits of a general summary for all minerals in each state and in the United States, and shows true conditions as to employees, wages, expenses, quantity, and value of the different products.

A similar method was followed in classifying the reports for some minerals in which a manufacturing process is carried on in connection with, and incident to, the mine or quarry. Instances of this character are, when limestone quarrying and cement manufacturing are done at a quarry and a part of the product of the quarry is sold in its crude state for building and other purposes, or when grindstones are made at a sandstone quarry and a portion of the quarried stone is sold for building or other purposes. Such quarries made only one report to the Bureau of the Census, and this was classified according to the product of chief value, the quantities and values of the different products being tabulated and presented separately in the reports on each mineral. For convenience in treatment the statistics for allied minerals or minerals used for similar purposes are grouped and discussed as a total and also individually. For instance, the report on "Abrasive materials" includes oilstones, whetstones, scythestones, grindstones, pulpstones, buhrstones, millstones, pumice, infusorial earth, tripoli, crystalline quartz, garnet, corundum, and emery.

A number of the substances usually included in reports on mineral products are the result of manufacturing processes, and therefore should not be included with statistics for mines and quarries. There are also a number of minerals that were not produced in commercial quantities in the United States during the year 1902, and therefore no statistics concerning them are given in this report.

The following summary shows the classification adopted for each mineral, the character of the substance included, and also the names and character of the substances omitted and the reasons for such omission.

Abrasive materials: This classification includes (1) abrasive materials that occur as rock formation and are cut and manufactured directly into the form desired, while retaining their original rock structure and appear-

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ance, as oilstones and grindstones; (2) abrasive materials that occur as a constituent of either a rock or a vein and have to be mechanically separated from the associated minerals and cleaned, as corundum, emery, and garnet.

Buhrstones and millstones: Many varieties of stone are used in the manufacture of buhrstones and millstones, and these names are retained because the stones were formerly used for the same purposes as the regular buhr. The millstone varies from a sandstone to a quartz conglomerate. It occurs along the eastern slopes of the Appalachian mountains from New York to North Carolina and is known by different names. In New York the stone is called "Esopus stone;" in Pennsylvania it is known as "Turkey hill" and "Cocalico;" in Virginia, as "Brush mountain" stone, and in North Carolina the name in former years was "North Carolina grit."

Corundum and emery: This classification includes the varieties of corundum known as sapphire, which embraces all corundums of whatever color, that are transparent to semitransparent; also the translucent to opaque varieties of all colors, and emery, which is a mechanical admixture of corundum and magnetite or hematite. Of the total production shown for this classification a very small proportion was corundum proper, the production consisting almost entirely of the emery variety. The statistics do not include the manufacture of artificial corundum.

Crystalline quartz: Under this head is included the quartz that is used principally as a wood finisher and in the manufacture of sandpaper, scouring soaps, etc. The larger proportion of this quartz is used in the pottery and glass industry and is included with flint and feldspar.

Garnet: The statistics relate to the production consumed in the manufacture of garnet paper and emery wheels. The paper is used very extensively in the manufacture of boots and shoes. Garnet is found in many of the crystalline rocks, usually associated with mica in pegmatitic dikes.

Grindstones and pulpstones: The grindstone classification is composed almost entirely of the stones cut from the Lower Carboniferous sandstone beds of Ohio and West Virginia and the Lower Marshall series of Michigan. The Ohio and West Virginia sandstone is called the "Berea grit," because it has been so extensively quarried at Berea, in Cuyahoga county, Ohio. It is generally a fine grained and homogeneous variety. The color varies from a light drab to a light or steel blue. The pulpstones included are made from the Peninsula grit of Ohio, and are used for grinding wood pulp for the manufacture of paper.

Infusorial earth, tripoli, and pumice: Here are included all porous, siliceous earths of organic origin used in the manufacture of polishing powders and scouring soaps, water filters, fireproof building materials, etc. This classification includes also the solid pumice stone and volcanic ash which are used in the manufacture of various polishing powders and scouring stones.

Oilstones, whetstones, and scythestones: The term "oilstone" is applied to all stones used for sharpening tools to which oil is generally applied, but the same stone may be called an oilstone or a whetstone and, perhaps, a scythestone. The materials from which these stones are made are variable, but are of sedimentary origin, and include quartz-mica-schist, sandstone, novaculite, and the intermediate stones.

Aluminum: The metal is obtained by manufacturing processes, and the statistics are therefore excluded from this report. The production, which amounted to 7,300,000 pounds, is mentioned in the report on bauxite, which is the chief raw material used in its manufacture.

Antimony: This mineral is used chiefly for making alloys with lead, tin, zinc, and other metals. The supply is obtained from foreign and domestic antimony ores, hard lead, and regulus, or metal. There was no production of antimony metal from domestic ores during 1902, and therefore no statistics are presented. The quantity derived from other sources was estimated at 12,510,739 pounds.

Arsenic: Arsenious oxide (white arsenic) is obtained in the treatment of gold, silver, lead, or other arsenical ores, and being a separate manufacture is not shown in census mining statistics. The production of arsenic for 1902, as reported by the Geological Survey, was 1,353 short tons, valued at $81,180.

Asbestos: Two distinct minerals are mined and sold under this name. One is a variety of amphibole and the other is the fibrous variety of serpentine, known as chrysotile. The latter variety is the more valuable, but the production of the United States consists principally of the former. The statistics cover the production of both varieties. Asbestos is used in the manufacture of fireproof materials and wherever a nonconductor of heat is desired.

Asphaltum and bituminous rock: This classification includes the product obtained from the mining of the various kinds of hydrocarbon rocks that have an asphaltic base, and some of the purer forms of bitumen, as elaterite, gilsonite, and uintaite. The statistics do not include the asphaltum by-products of petroleum refineries, these being classed as manufactures, or the semifluid bitumen maltha, or brea.

Ball clay: See Clay.

Barytes: What is known commercially as barytes is barite, a heavy, white mineral, used principally in the manufacture of paints and often called heavy spar, from its high specific gravity. A large proportion of this mineral is mined in an irregular manner by farmers and others who work at such times as their other employment will permit. The reports for all classes of operators are included.

Bauxite: The statistics for bauxite cover the entire production, which is consumed mainly in the manufacture of aluminum, although considerable is used for the manufacture of aluminum sulphate and crystallized alum.

Bismuth: There was no production of bismuth ore reported for 1902. The production in 1901 was reported as 318.6 short tons.

Bituminous rock: See Asphaltum and bituminous rock.

Bluestone: See Stone—Sandstones and quartzites.

Borax: The entire production of this most important salt of boric acid was obtained from the colemanite deposits in California and the marsh deposits of Nevada and Oregon. The statistics include the refining of the crude borax, which is closely allied with the mining.

Bromine: Bromine is one of the elements related in its chemical qualities to chlorine and iodine. It is a deep reddish brown liquid of a very disagreeable odor, emitting a brownish vapor at ordinary temperature. In combination it is found in minute quantities in sea water and many saline springs; occurs also in the mineral bromyrite. A large proportion of the product is obtained from deposits in Michigan. The processes are somewhat similar to those used in the production of salt. Both salt and bromine are classed as manufactures and excluded from this report.

Buhrstones: See Abrasive materials—Buhrstones and millstones.

Carbonate of soda: This product is the result of processes similar to those used in the manufacture of salt, being obtained by the solar or artificial evaporation of alkaline waters. It, as well as salt, was classed as a manufactured product at the census of 1900. The statistics, therefore, are omitted from this report. The entire production, 4,900 tons of refined soda ash, valued at $50,000, for the year 1902 was obtained from one establishment, the Inyo Development Company, of Inyo county, Cal., with general offices at Carson City, Nevada.

Carborundum: Is a product of manufactures, and, therefore, not included in this report. Its composition is, carbon, 32 per cent; silicon, 68 per cent. It comes from the furnace in the shape of black crystals, which are crushed, washed, dried, and sifted to uniform size. At the factory of the sole manufacturers, at Niagara Falls, the production in 1902 was 3,741,500 pounds.

Celestite: See Strontium ores.

Cement: The statistics relate only to the cement—Portland and natural rock—manufactured by establishments engaged in quarrying, but in addition to this product the total production of cement as reported to the Geological Survey is also mentioned. The marl excavated and used for cement is shown here, and not under Marl. The manufacture of pozzuolana, or cement from furnace slag, is not included.

Chromic iron ore: See Steel hardening metals—Chrome ore.

Clay: Includes kaolin, ball clay, fire clay, slip clay, stoneware clay, pipe clay, terra cotta, and other varieties of clay mined and sold as such. The statistics do not include the clay mined by operators who consume their output in the manufacture of brick, pottery, and other clay products.

Coal: Both the anthracite and the bituminous coal mines are included in this classification, the statistics being presented separately. Under bituminous is included semibituminous, lignite, and some coal locally known as anthracite. The anthracite is Pennsylvania anthracite, which is practically the whole production. The totals for bituminous coal include the output of the irregular, small producers.

Cobalt: See Steel hardening metals—Nickel and cobalt.

Coke: Coke is not shown, because a manufactured article and reported as such at the census of 1900.

Copper ore: The statistics of employees, wages, and expenses relate to the mines producing copper as a product of chief value; but the total quantity and value of the copper obtained from all ores, including the product of silver mines, is included, the amounts obtained from the different classes of ore being given separately. (See Gold and silver.)

Corundum: See Abrasive materials—Corundum and emery.

Crushed steel: This is a manufactured product and therefore not included in this report. It is used by granite and marble cutters; also in sawing, grinding, rubbing, and polishing stone, and by glass grinders. The sole producers manufactured 735,000 pounds in 1902.

Cryolite: There was no production of this mineral in the United States in 1902. It is a fluoride of sodium and aluminum, found almost exclusively in Greenland and sometimes called Greenland spar. It is used in the manufacture of aluminum and sodium salts.

Crystalline quartz: See Abrasive materials.

Dolomites: See Stone—Limestones and dolomites.

Emery: See Abrasive materials—Corundum and emery.

Feldspar: See Flint and feldspar.

Ferromanganese: This is an alloy of iron and manganese used in the manufacture of Bessemer steel. It is a manufactured article and therefore is not included in census mining statistics.

Fibrous talc: See Talc and soapstone.

Fire clay: See Clay.

Flint: See Flint and feldspar.

Flint and feldspar: This classification includes the flint or quartz mined as such, but does not include the crystalline quartz used for wood finishing or the manufacture of scouring soaps, which is shown under the class of Abrasive materials. Statistics are also shown for the entire production of feldspar, which is used largely in the pottery and porcelain industry and in the manufacture of scouring soaps and wood fillers.

Fluorspar: Fluorite of fluorspar is a calcium fluoride that is generally found in veins in limestones, sandstones, mica slate, clay, slate, and gneiss. The statistics cover the entire production, practically all of which is used as a fluxing material in steel works and blast furnaces.

Fuller's earth: The greatest part of this earth—a material resembling clay, but commonly lacking plasticity—is obtained in the vicinity of Quincy, Fla. The entire production is included. It is used in fulling wool and deodorizing and clarifying fats, oils, and greases. Refineries of lard, cottolene, and allied products are important consumers.

Garnet: See Abrasive materials.

Gold and silver: The statistics for gold and silver embrace both deep and placer mines and development work, and also the reduction mills and ore dressing works. In many instances gold and silver, and in some cases copper and lead, are obtained from the same ore. The statistics of employees, wages, and expenses for the precious metals are, therefore, presented in the same tables, but the production of each metal is shown separately. The value of the product is the value at the mine to the miner.

Granite: See Stone—Siliceous crystalline rocks.

Graphite: This mineral is sometimes called plumbago, black lead, or pot lead. It occurs as a form of carbon, and is the last form assumed in the natural change of vegetable matter into a mineral. The statistics include only the production and refining of the natural graphite, which is classed either as crystalline or amorphous.

Greensand marl: See Marl.

Grindstones: See Abrasive materials—Grindstones and pulpstones.

Grindstones and pulpstones: See Abrasive materials.

Gypsum: The statistics cover the crude gypsum—a calcium sulphate—marketed as such; also the product ground into land plaster and that calcined into plaster of Paris and wall or cement plaster.

Hübnerite: See Steel hardening metals—Tungsten.

Infusorial earth, tripoli, and pumice: See Abrasive materials.

Iridium: See Platinum and iridium.

Iron ore: The statistics include the different varieties of iron ore generally classed as (1) red hematite, including all anhydrous hematites, known by various names, such as red hematite, specular, micaceous, fossil, slate iron ore, martite, blue hematite, etc.; (2) brown hematite, including the varieties of hydrated sesquioxide of iron, recognized as limonite, gothite, turgite, bog ore, pipe ore, etc.; (3) magnetite, those ores in which iron occurs as magnetic oxide and including some martite, which is mined with the magnetite; (4) carbonate, those ores which contain a considerable amount of carbonic acid, such as spathic ore, blackband, siderite, clay, ironstone, etc. The statistics for manganiferous iron ores are also included. Argentiferous manganiferous iron ores are included in some cases with iron ores and in other cases with silver, according to the relative commercial value of the silver and iron contents.

Kaolin: See Clay.

Lead ore: See Lead and zinc ore.

Lead and zinc ore: Only nonauriferous and nonargentiferous lead and zinc ores are included. It is impracticable, in a majority of cases, to separate the statistics of employees, wages, and expenses incident to the production of each metal, and they are combined in the tables, but the quantity and value of each, and, in some cases, other statistics are shown separately. Totals for both lead and zinc include the dressing of the ore at the mine preparatory to its treatment at the smelter. The value is that of the contents at the mine to the miner. A considerable proportion of the lead product is obtained from silver ore, which carries with it also some gold. All the statistics relating to argentiferous lead ores, including the value of product, are given in the report for gold and silver mines, shown under Gold and silver.

Lepidolite: See Lithium ore.

Limestone: See Stone—Limestones and dolomites.

Limestones and dolomites: See Stone.

Litharge: This is a lead pigment, classed with white lead, red lead, etc., and being obtained by a process of manufacture is not included in statistics of mining.

Lithium ore: The two minerals thus far mined for their lithium contents are lepidolite and spodumene. Lepidolite is a lithia mica, in part a metasilicate of aluminum with potassium and lithium and varying amounts of fluorine and hydroxyl. Spodumene is a metasilicate of aluminum and lithium, generally containing a little sodium. It is not the metal lithium that is used in the arts, but its salts, principally lithium carbonate. This is used extensively in the preparation of mineral waters for medicinal purposes and in the manufacture of effervescing lithia tablets.

Lithographic stone: This is an even grained, compact limestone, usually of a drab or buff color, like that quarried at Solnhofen, Germany, and is used by lithographers. No production was reported for the year 1902. A report was received from a quarry in Kentucky that did only development work and prospecting. Lithographic stone has been found in Talladega county, Ala.; in Kern county, Cal.; in Illinois; at Anamosa, Jones county, and in Van Buren county, Iowa; near Elizabethtown, Hardin county, and in Clinton, Estill, Kenton, Rowan, and Wayne counties, Ky.; at Saverton, Ralls county, Mo.; in Clay and Overton counties, Tenn.; and in Llano county, Tex. The world's supply, however, has been obtained mostly from the quarries at Solnhofen, Bavaria. The imports for the year ending June 30, 1903, were valued at $131,015.

Magnesite: This is magnesium carbonate. The mining is confined to California. Only one producer reported, and the statistics are grouped with All other minerals. The mineral is used especially in the manufacture of magnesite bricks for the refractory lining of furnaces and the manufacture of carbon-dioxide gas. When crude magnesite is decomposed by sulphuric acid there is a by-product of magnesium sulphate, or Epsom salts. Both crude and calcined magnesite are included in the statistics.

Manganese ore: The statistics for manganese ore include ores carrying over 44.3 per cent of metallic manganese. The manganiferous iron ores are treated under "Iron ores," and the manganiferous silver ores in some cases under "Silver" and in other cases under "Iron ores," according to the relative commercial value of the silver and iron contents. The chief use of manganese is in the manufacture of Bessemer steel.

Marble: See Stone.

Marl: Marl includes the green, blue, red, and yellow clayish earths used as fertilizers. The marl deposits extend from New Jersey to North Carolina, but the mines included in the statistics are in New Jersey and Virginia. In New Jersey the entire product is applied to the soil in the natural state, while in Virginia it is dried and ground for use in commercial fertilizers.

Mica: There are two varieties of commercial value—muscovite and phlogopite, but the former is more commonly found and mined. The value of mica depends on its occurrence in blocks or masses that are capable of being split into sheets a square inch or more in size, and the value of these sheets increases with their size, which varies from 1 inch square to 8 by 10 inches. Soap mica, ground to a flour, is used in the manufacture of wall papers, lubricants, fireproofing materials, novelties, etc. Sheet mica is used chiefly in stoves, for chimneys of incandescent lights, and for the insulation of electrical apparatus. The statistics embrace both sheet and scrap mica. A considerable proportion was mined by small, irregular operators, and the statistics for them are included in the total.

Millstones: See Abrasive materials—Buhrstones and millstones.

Mineral paints: See Mineral pigments, crude.

Mineral pigments, crude: Include the production of ores used in the manufacture of mineral paints. They consist of iron ores (red and brown hematites) that are ground and used in the manufacture of metallic paint, and are not included in the production of iron ores for the manufacture of iron; clay or other earths, including some mined as "Venetian red," containing iron used in making yellow, red, and brown pigments (such as ocher, umber, sienna, etc.); carbonate of zinc, slate (or shale) and soapstone, ground for pigment. No statistics of manufacture are given except such as are inseparable from the mining.

Mineral waters: The report on manufactures of the Twelfth Census and the annual reports of the Geological Survey contain statistics concerning the production and sale of mineral waters. These statistics have been omitted from the census of 1902 for the reason that mineral waters are not commercially classed as the product of a mine or quarry. They are produced under conditions that are entirely different from those prevailing in the mining industries. The employees engaged in the industry are devoted almost exclusively to the preparation of the product for the market, as there is practically no expense incident to the production of the water itself. The total production for 1902, as reported by the Geological Survey, was 64,859,451 gallons, valued at $8,793,761.

Molybdenum: See Steel hardening metals.

Monazite: This mineral is essentially an anhydrous phosphate of the rare earth metals cerium, lanthanum, and didymium. It is mined for its thoria contents, which are usually from 3 to 9 per cent, but have been found to vary from a fraction of 1 per cent to 32 per cent. The commercial deposits of monazite are found in placers of streams and rivers, also in old sand and gravel deposits of former streams, and are worked by sluicing the sands and gravels, principally by small, irregular operators, just as placer gold is washed. The thoria in the monazite and, in much smaller quantities, the lanthanum and didymium are used in the manufacture of the cylindrical hood or mantle of incandescent gaslights. The cerium oxalate obtained in the separation of the oxides is used in pharmacy.

Natural gas: The statistics relate exclusively to the production of natural gas, and the value of the product is the value at the point of consumption. The petroleum produced by gas companies and the statistics pertaining to it are included in those for petroleum.

Nickel: See Steel hardening metals—Nickel and cobalt.

Nickel and cobalt: See Steel hardening metals.

Nitrate of soda: No production of nitrate of soda was reported for the United States during the year 1902. A schedule was received from one California company owning a mine in Nevada, at which development work only was done. The world's supply is obtained principally from the natural beds of Chile. The total imports from all sources for 1902 were 661,348,800 pounds, valued at $5,996,205.

Novaculite: See Abrasive materials—Oilstones, whetstones, and scythestones.

Ocher: Ocher is a pigment used in the manufacture of mineral paints. See Mineral pigments, crude.

Oilstones: See Abrasive materials—Oilstones, whetstones, and scythestones.

Orange mineral: This is a lead oxide pigment largely used for paints. Being classed as a manufacture, it is not included in Census mining statistics.

Ozocerite: This mineral is also known as mineral wax. No production of the mineral, as such, was reported for 1902. The entire product is obtained in the treatment of asphaltum, and therefore is classed for census purposes as a product of manufacture.

Petroleum: The statistics relate exclusively to the production of crude petroleum. Petroleum refining is classed as a manufacture, and the statistics are included in the census of manufactures of 1900. The production of natural gas by petroleum companies has been eliminated from the reports for such companies, and the statistics are included in the classification of natural gas.

Phosphate rock: This is a name given to various mineral deposits, consisting largely of calcium phosphates or iron and alumina phosphates, and used in the manufacture of commercial fertilizers. The statistics include the preparation of the rock for market when this is done at the quarry.

Pig iron: This is classed as a manufacture and was shown at the census of 1900. It is not included in mining statistics.

Pipe clay: See Clay.

Platinum: See Platinum and iridium.

Platinum and iridium: Almost the entire production of the rare metal platinum is obtained from placer gold mines. Iridium is closely associated with platinum and, not amalgamating, has not always been saved. Some platinum and iridium are also secured in the refining of gold. Platinum occurs generally in the native state. It is used chiefly in chemical manufacture and analysis and in electrical work. Iridium is used for the knife edges of balances and other hard wearing surfaces. There were no mines engaged in the production of platinum ore as a product of chief value; therefore it is impossible to show statistics of employees, wages, and expenses, such statistics being included in the report for gold. The production of platinum in 1902 from domestic mines, as reported by the United States Geological Survey, was 94 ounces, valued at $1,814, and of iridium, 20 ounces.

Pozzuolana or slag cement: This is a manufacture and is therefore not included in statistics of mining.

Precious stones: Under this heading are classed the following gems mined or found accidentally in this country in 1902: Sapphire, beryl, emerald, tourmaline, peridot, quartz, amethyst, agates, chrysoprase, silicified wood, opal, garnet, rhodolite, amazon stone, turquoise, chlorastrolite, mesolite, pyrite, anthracite, and catlinite. A considerable proportion of the product was the result of irregular work or incidental findings, and no employees, wages, or other expenses were reported for this portion.

Pulpstones: See Abrasive materials—Grindstones and pulpstones.

Pumice: See Abrasive materials—Infusorial earth, tripoli, and pumice.

Pyrite: See Sulphur and pyrite.

Quartzites: See Stone—Sandstones and quartzites.

Quicksilver: The production of this silver-white metal fluid is confined to California and Texas. The statistics include the production and the reduction of the cinnabar from which the quicksilver is principally obtained. The chief use of quicksilver, or mercury (its scientific name), is in the metallurgical treatment of gold and silver. It is also employed in the manufacture of vermilion, a pigment, in the manufacture of physical instruments, and as a medicine.

Red lead: Red lead is classed as a manufacture, and is not shown in mining statistics.

Rutile: See Steel hardening metals.

Salt: For census purposes salt is classed as a manufacture, and the statistics are included in the report on manufactures of the Twelfth Census. The total production for 1902, as reported by the Geological Survey, was 23,849,221 barrels, valued at $5,668,636. The chief salt producing states are Michigan and New York.

Sandstone: See Stone—Sandstones and quartzites.

Sandstones and quartzites: See Stone.

Scheelite: See Steel hardening metals—Tungsten.

Scythestones: See Abrasive materials—Oilstones, whetstones, and scythestones.

Sienna: Sienna is a pigment used in the manufacture of mineral paint. See Mineral pigments, crude.

Silica sand: See Stone.

Siliceous crystalline rocks: See Stone.

Silver: See Gold and silver.

Slate: See Stone.

Slate, ground for pigment: See Mineral pigments, crude.

Slip clay: See Clay.

Soapstone: See Talc and soapstone.

Spiegeleisen: This is an alloy of iron and manganese used in the manufacture of Bessemer steel, and, being a manufacture, is not included in census mining statistics.

Spodumene: See Lithium ore.

STEEL HARDENING METALS: The statistics for the several metals (except for manganese, which is shown separately) that are utilized largely, or in an experimental way, in the manufacture of steel or of steel products have been grouped under this classification. They are chromium, molybdenum, nickel, titanium, tungsten, uranium, and vanadium. Cobalt is included because it is associated with nickel in the matte. Except for nickel and cobalt, the value of which is the value of the matte at the mine, and tungsten ores, the value of which is their value more or less concentrated, the statistics are for the crude ores. Under this classification are shown chrome ore, molybdenum, nickel and cobalt, rutile, tungsten, and uranium and vanadium.

Chrome ore: This includes the statistics for chromite or chromic iron ore. Only one producer was reported. The ore is used in the manufacture of bricks for basic open-hearth furnaces, and from the metal a ferrochromium alloy is made which is employed in the manufacture of chromium steel. The chromium salts obtained are used in dyeing and in the manufacture of coloring pigments.

Molybdenum: The chief source of this metal is the mineral molybdenite, which is usually found foliated, massive or in scales, with a perfect basal cleavage and a metallic luster. Molybdenite generally occurs embedded in or disseminated through crystalline rocks, principally granite, gneiss, and granular limestone, and is found abundantly in the Western states. Besides being used in chemistry, molybdenum has in the last few years been found to give very beneficial properties to steel.

Nickel and cobalt: Most of the ores that contain one of these metals contain at least a small amount of the other, and in the smelting of the ores both the nickel and the cobalt go into the matte which is to be refined. The product is obtained principally from the smelting of lead ores at Mine La Motte, Mo. Nickel is used in the manufacture of tableware and for coinage and miscellaneous purposes, but its most important use is in the manufacture of a special steel from which armor plates, turrets, propeller shafts, etc., are made.

Rutile: Rutile is the only titanium mineral mined for commercial purposes. Considerable experimental work has been done with titanium in the manufacture of steel, but so far as known the metal has not yet been used in this way commercially. Iron has been made which contains a considerable proportion of titanium. Deposits are found in a number of states, but the beds in Virginia are the only ones that were productive in 1902. The principal use of rutile at present is as titanium oxide for coloring porcelain and in the manufacture of artificial teeth.

Tungsten: The sources of tungsten are scheelite, wolframite, and hübnerite. Of these, the one that can be used most advantageously in reducing it to the metal, or to the ferroalloy, is scheelite, a tungstate of calcium. Wolframite, which is the most abundant of the tungsten ores, is a tungstate of iron and manganese. Hübnerite is very similar to wolframite, and is essentially a manganese tungstate. The chief use of tungsten, either in the form of the alloy, as ferrotungsten, or as the powdered metal, is in the manufacture of tungsten steel.

Uranium and vanadium: The minerals that are the source of uranium are uraninite, gummite (an alteration product of uraninite), and carnotite. The last mineral contains also a considerable percentage of vanadium, a lead vanadate. Both uranium and vanadium are used in an experimental way in the manufacture of steel alloys, and increase the tensile strength and toughness of the steel. The metals are also in demand for their salts.

STONE: The statistics are shown under the following heads: Limestones and dolomites, marble, sandstones and quartzites, silica sand, siliceous crystalline rocks, and slate.

Limestones and dolomites: These include, besides the calcium carbonate (limestones), also stone containing calcium carbonate and magnesium carbonate in varying proportions (dolomites); also fossiliferous shell and coral limestones. The statistics include limestone used for iron flux and in the manufacture of lime.

Marble: Marble is limestone that by action of heat has been transformed to crystalline form. With marble is included some onyx marble, or travertine; also a small amount of serpentine or verd antique.

Sandstones and quartzites: This classification includes all consolidated sands. Among the varieties are the bluestone of New York and Pennsylvania, and calcareous sandstone; also the jasper of southern Minnesota, the lava of Douglas county, Colo.; ganister, a quartzite used as refractory material in furnaces, and some bituminous sandstone.

Silica sand: The crushing and grinding of the rock for the production of silica sand, used largely in the manufacture of glass, is in a number of cases done by sandstone quarries from which stone is sold for other purposes. But in cases where all, or practically all, of the product of the quarry was used for the manufacture of this sand it was treated as a quarry and the statistics are included under this classification. They do not include the digging of sand from sand banks, river beds, etc.

Siliceous crystalline rocks: This group of rocks includes granite, gneiss, mica schist, lava, andesite, syenite, quartz, porphyry, and trap. These are used for various purposes, such as building stone, foundation work, monumental stone, paving blocks, curbstone and flagstone, rubble and crushed stone for riprap, macadam roads, concrete, and railroad ballast. The kinds of stone treated under trap rock are trap, diabase, and diorite, which are quarried extensively in the New England states, and in New York, New Jersey, and Pennsylvania, and are used largely for paving stones and road metal; basalt, quarried in California for the same purposes; and gabbro.

Slate: Slate is quarried principally for roofing, but also for manufacture into slabs, slates, slate pencils, etc., the milling necessarily being done at the quarries while the stock is wet. Slate ground for pigment is included in Mineral pigments, crude.

Stoneware clay: See Clay.

Strontianite: See Strontium ores.

Strontium ores: The two minerals that are sources of strontium salts are celestite and strontianite. It is not the metal strontium that is used commercially, but its salts. Those that are most in demand are strontium oxide and strontium hydroxide, which are used in refining beet sugar and also in the defecation of sugar contained in molasses. Other uses are in the manufacture of pyrotechnics, medicines, and chemicals. No production of strontium minerals has been reported since 1897, when 40 tons of celestite, out of 150 tons mined, was shipped from Put in Bay, Strontian Island, Ottawa county, Ohio.

Sulphur: See Sulphur and pyrite.

Sulphur and pyrite: The statistics for sulphur and pyrite, from which sulphuric acid is largely obtained, are grouped so as not to disclose the operations of a company engaged in the production of sulphur. By far the greater part of the sulphur is consumed in the manufacture of paper stock by the sulphite process.

There are two kinds of pyrite, iron pyrites and copper pyrites. Pyrite, which is mined principally for its sulphur contents, is commonly called iron pyrites, but that term includes marcasite as well as pyrrhotite. Practically all the ore is treated for the manufacture of sulphuric acid. The acid is used for medicinal and chemical purposes, and very largely in the refining of oils, manufacture of paper, fertilizers, etc. Some pyrite is mined as a by-product of coal, and this is included in the total.

Talc and soapstone: The statistics include a small production of serpentine and the production of pyrophyllite, both minerals being mined and used for the same purposes as talc. Three kinds of talc are included under this head: Foliated, from which talcum powders, tailors' pencils, etc., are made; fibrous, wholly mined in the state of New York and used in the manufacture of paper; and massive (which is steatite or soapstone), used for slabs, washtubs, sanitary work, etc. The manufacturing processes when conducted at the mines are included in the statistics.

Terra cotta: See Clay.

Tin: There was no production of tin ore in the United States during the year 1902. All the tin of commerce is obtained from the dioxide, which is called cassiterite by the mineralogist and tinstone by the miner. Some experimental or development work was done in the Black Hills region, and work was resumed on the deposits in the Santa Ana mountains in southern California. Tin is used principally in the manufacture of tin plate sheet metal coated with tin. It also forms a part of several important alloys.

Trap rock: See Stone—Siliceous crystalline rocks.

Tripoli: See Abrasive materials—Infusorial earth, tripoli, and pumice.

Tungsten: See Steel hardening metals.

Umber: Umber is a pigment used in the manufacture of paints. See Mineral pigments, crude.

Uranium: See Steel hardening metals–Uranium and vanadium.

Uranium and vanadium: See Steel hardening metals.

Vanadium: See Steel hardening metals.

Venetian red: See Mineral pigments, crude.

Whetstones: See Abrasive materials–Oilstones, whetstones, and scythestones.

White lead: White lead is classed as a manufacture, and not shown in the census mining statistics.

Wolframite: See Steel hardening metals–Tungsten.

Zinc ore: See Lead and zinc ores.

Zinc white: This is a manufacture, and not included in the mining census.

There are many varieties of ores and metals included in the different groups or classifications. These ores and metals have been described with more or less detail in the reports for each classification, but in order to assist in the identification of the ore, the metal, and its chemical constituents, the following table, with the accompanying descriptive text relative to all ores of economic importance, is given:[1]

ORES OF ECONOMIC IMPORTANCE.

The accompanying table has been compiled from several authoritative sources,[2] the ores under each metal being arranged in the order of mineral species given in Dana's System of Mineralogy, sixth edition. The percentage compositions given in that work have been adopted and the metallic content has been calculated therefrom where necessary. In a mining region one often hears ores spoken of as running 90 per cent lead, 80 per cent zinc, and so on, when the purest crystallized minerals do not contain such amounts of the metals. The fourth column of this table shows the highest possible percentage of metal in the various ores, and the fifth column indicates the corresponding amounts of metal in the short ton (2,000 pounds) of pure ore. In a few instances the ore is of such variable or uncertain composition that the highest percentage of metal given by actual analysis has been quoted, instead of any theoretical amount. This has been indicated in the table by the use of brackets.

It must be remembered, however, that, with the exception of some ores of iron, tin, and quicksilver (mercury), the metalliferous ores as found in run of mine are not pure or unmixed minerals; on the contrary, they are in complex associations with one another. This is especially the case with silver ores (of which there are some thirty varieties, counting rare combinations), and, to a smaller degree, with ores of gold, nickel, antimony, zinc, and some other metals. Often it is the constituent of low ratio but high pecuniary value in these mixed ores that makes the mine worth working; or such a constituent may be the by-product of reduction which makes mining profitable. Furthermore, even with relatively pure ores, the accompanying gangue minerals—for instance, quartz, calcite, barite, and fluorite—seldom can be wholly removed by hand sorting or other means of concentration. These impurities and the unavoidable losses during the processes of reduction make the amount of metal actually won from an ore fall far below its theoretical chemical composition. The principal use of the table is to show the highest possible amount of metal that could be obtained from pure ores.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1901, page 967 ff.

[2] Lehre von den Erzlagerstätten, by Richard Beck, Berlin, 1901; Ore Deposits of the United States and Canada, by James F. Kemp, fourth edition, New York and London, 1901; A System of Mineralogy, by Edward S. Dana, sixth edition, New York, 1895.

Percentage of metal contained in ores of economic importance.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Aluminum.				
Fluoride	Cryolite	Na_3AlF_6	12.8	256	Used also as a source of sodium and its compounds.
Oxide	Corundum	Al_2O_3	52.9	1,058	Used, however, mostly as an abrasive.
Oxide	Bauxite	$Al_2O_3.2\ H_2O$	39.1	792	Often furnishes more aluminum through presence of other oxides in the ore. Principal ore.
Silicate	Kaolinite	$2\ H_2O.Al_2O_3.2\ SiO_2$	20.9	418	
	Antimony.				
Sulphide	Stibnite (gray antimony, antimonite)	Sb_2S_3	71.4	1,428	Chief ore; often associated with galena.
Oxide	Valentinite (white antimony, senarmontite).	Sb_2O_3	83.3	1,666	
Oxide	Stibiconite (antimony ocher)	Sb_2O_4	74.5	1,490	Often furnishes more antimony through presence of other oxides. A by-product in lead smelting.
	Arsenic.				
Metallic	Native arsenic	As	100	2,000	Contains Sb, Ni, Fe, Mn as impurities. Rare.
Sulphide	Realgar	As_2S_2	70.1	1,402	
Sulphide	Orpiment (auripigment)	As_2S_3	61	1,220	
Arsenide	Lollingite	$FeAs_2$	72.8	1,456	Grades into leucopyrite, Fe_3As_4, with As 64.1 per cent.
Sulpharsenide	Arsenopyrite (mispickel)	FeAsS	46	920	Arsenic is obtained also from some nickel and cobalt ores, particularly smaltite and cobaltite.
	Bismuth.				
Metallic	Native bismuth	Bi	100	2,000	Rare.
Sulphide	Bismuthinite (bismuth glance)	Bi_2S_3	81.2	1,624	
Oxide	Bismite (bismuth ocher)	Bi_2O_3	89.6	1,792	
Carbonate	Bismutite (carbonate of bismuth)	$3\ BiCO_5 + H_2Bi_2O_6 + aq$	80.6	1,612	Composition variable.
Silicate	Eulytite	$Bi_4Si_3O_{12}$	75	1,500	Rare
	Cadmium.				
Sulphide	Greenockite	CdS_2	77.7	1,554	The cadmium of commerce, however, is obtained from cadmiferous sphalerite (zinc blende).
	Chromium.				
Oxide (or chromate).	Chromite (chromic iron)	$FeCr_2O_4$	52.1 Cr_2O_3 = 68.0	1,042 1,360	Often has MgO and Fe_2O_3 replacing the FeO and Cr_2O_3.
	Cobalt.				
Sulphide	Linnaeite (cobalt pyrites)	Co_3S_4	57.9	1,158	Proportions variable. Co replaced usually to some extent by Ni, Fe, and Cu.
Arsenide	Smaltite	$CoAs_2$	28.2	564	Grades insensibly into chloanthite, $NiAs_2$.
Sulpharsenide	Cobaltite	CoAsS	35.5	710	
Arsenide	Skutterudite	$CoAs_3$	20.7	414	
Sulpharsenide	Glaucodot	(CoFe)AsS	23.8	476	Proportions variable.
Oxide	Asbolite (earthy cobalt)	Doubtful	Up to 32	640	
Arsenate	Erythrite (cobalt bloom)	$Co_3As_2O_8 + 8\ H_2O$	29.5	590	Cobalt is obtained also from arsenopyrite and chalcopyrite.
	Copper.				
Metallic	Native copper	Cu	100	2,000	Usually contains some silver.
Sulphide	Chalcocite (copper glance)	Cu_2S	79.8	1,596	
Sulphide	Covellite (indigo copper)	CuS	66.4	1,328	
Sulphide	Bornite (peacock ore)	Cu_3FeS_3	55.5	1,110	Often enriched by mechanical admixture of chalcocite.
Sulphide	Chalcopyrite (copper pyrites)	$CuFeS_2$	34.5	690	
Sulphantimonite	Bournonite	$(Pb, Cu_2)_3Sb_2S_6$	13	260	Contains 42.5 per cent lead and 24.7 per cent antimony.
Sulphantimonite	Tetrahedrite	$Cu_8Sb_2S_7$	52.1	1,042	Sb 24.8 per cent. Grades into tennantite, the sulpharsenite of Cu, containing Cu 57.5 per cent, As 17 per cent.
Sulpharsenite	Enargite	Cu_3AsS_4	48.3	966	As 19.1 per cent. Grades into famatinite, the sulphantimonite of Cu, containing Cu 43.3 per cent, Sb 27.4 per cent.
Chloride	Atacamite	$CuCl_2.3\ Cu(OH)_2$	64.5	1,290	Sometimes yields more copper, on account of admixtures.
Oxide	Cuprite (ruby copper)	Cu_2O	88.8	1,776	
Oxide	Tenorite (melaconite, black copper).	CuO	79.8	1,596	
Carbonate	Malachite (green carbonate of copper)	$CuCO_3.Cu(OH)_2$	57.4	1,148	
Carbonate	Azurite (blue carbonate of copper)	$2\ CuCO_3.Cu(OH)_2$	55.2	1,104	
Carbonate	Chrysocolla	$CuSiO_3 + 2\ H_2O$	36.1	722	Pyrite and pyrrhotite sometimes contain copper enough to pay for extraction.
	Gold.				
Metallic	Native gold	Au	100	2,000	Usually contains silver, up to 16 per cent. When more than 16 per cent silver is present the alloy is called electrum.
Telluride	Petzite	$(Ag, Au)_2Te$	25.5	510	Proportions variable. This percentage corresponds to ratio Ag : Au = 3 : 1.
Telluride	Sylvanite	$(Au, Ag)Te_2$	24.5	490	Proportions variable. This percentage corresponds to ratio Au : Ag = 1 : 1. Reported up to 29.35 Au.
Telluride	Krennerite	$(Ag, Au)Te_2$ (?)	34.8	696	Composition uncertain. Calaverite, another telluride, has yielded Au 40.92 per cent. Analyses have given from 5.8 per cent to 12.75 per cent Ag.
Sulpho-telluride	Nagyagite	$Au_2Pb_{14}Sb_3Te_7S_{17}$	7.46	149	Not common. Gold content calculated from average of recent analyses given by Dana.
					Gold is recovered also from pyrite, arsenopyrite, chalcopyrite, stibnite, and sphalerite (blende).
	Iridium.				
Metallic	Iridosmine	Ir Os	{40	800}	Variable.
Metallic	Platiniridium	Pt Ir			Variable.
	Iron.				
Oxide	Hematite (specular iron ore, red hematite).	Fe_2O_3	70	1,400	
Oxide	Martite (a variety of hematite)	Fe_2O_3	70	1,400	Replacing magnetite in Lake Superior region.
Oxide	Ilmenite (menaccanite)	$FeTiO_3$	47.3	946	Too refractory for use as a source of iron.
Oxide	Magnetite (magnetic iron ore)	Fe_3O_4	72.4	1,448	
Oxide	Franklinite	$(Fe, Zn, Mn)O.(Fe, Mn)_2O_3$	44.4	888	An important ore of zinc in northern New Jersey.
Oxide	Turgite	$2\ Fe_2O_3—H_2O$	66.2	1,324	Often confounded with hematite.
Oxide	Limonite (bog iron ore, brown hematite).	$2\ Fe_2O_3—3\ H_2O$	59.8	1,196	

Percentage of metal contained in ores of economic importance—Continued.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Iron—Continued.				
Oxide	Gothite	$Fe_2O_3.H_2O$	62.9	1,258	Often confounded with limonite.
Carbonate	Siderite (spathic iron ore)	$FeCO_3$	48.2	964	
Silicate	Chamosite	$FeO, MgO, Al_2O_3, SiO_2, H_2O$	47	940	Uncertain composition. Iron declines to 33 per cent.
Sulphide	Pyrite (iron pyrites)	FeS_2	46.6	932	Contain 53.4 per cent sulphur and are used in the manufacture of sulphuric acid (oil of vitriol), sometimes treated also for gold content. Pyrites residue (=purple ore) is a commercial source of iron.
Sulphide	Marcasite (iron pyrites, mundic)				
	Lead.				
Sulphide	Galena ("lead," lead glance)	PbS	86.6	1,732	Is also a very important source of silver.
Sulphantimonite	Jamesonite (feather ore)	$Pb_2Sb_2S_5$	50.8	1,016	Contains 29.5 per cent antimony.
Sulphantimonite	Bournonite	$(Pb, Cu_2)_3Sb_2S_6$	42.5	850	Copper, 13 per cent; antimony, 24.7 per cent.
Sulphantimonite	Boulangerite	$Pb_3Sb_2S_6$	58.9	1,178	Antimony, 22.8 per cent.
Carbonate	Cerussite (white lead ore)	$PbCO_3$	77.5	1,550	
Chloro-phosphate	Pyromorphite	$3Pb_3P_2O_8.PbCl_2$	76.3	1,526	
Chloro-arsenate	Mimetite	$3Pb_3As_2O_8.PbCl_2$	69.5	1,390	
Sulphate	Anglesite (lead vitriol)	$PbSO_4$	68.3	1,366	
	Manganese.				
Oxide	Franklinite	$(Fe,Zn,Mn)O.(FeMn)_2O_3$	[20.0	400]	Proportions very variable. Important ore of zinc in northern New Jersey; manganese not saved.
Oxide	Hausmannite	Mn_3O_4	72.5	1,450	
Oxide	Braunite	$3Mn_2O_3.MnSiO_3$	63.5	1,270	
Oxide	Polianite	MnO_2	63.1	1,262	
Oxide	Pyrolusite	MnO_2	63.1	1,262	Principal source
Oxide	Manganite	$Mn_2O_3.H_2O$	62.4	1,248	
Manganate	Psilomelane	H_4MnO_5 (?)	[58.6	1,172]	Proportions and composition variable.
Oxide	Wad	$MnO_2 + MnO + H_2O$	[69.2	1,384]	Proportions and composition variable.
Carbonate	Rhodochrosite	$MnCO_3$	47.8	956	
Silicate	Rhodonite	$MnSiO_3$	41.9	839	
	Mercury (quicksilver).				
Sulphide	Metacinnabarite	HgS	86.2	1,724	
Selenide	Tiemannite	$HgSe$	71.7	1,434	
Sulphoselenide	Onofrite	$Hg(S,Se)$	83.8	1,676	Calculated for the ratio S : Se = 6 : 1.
Sulphide	Cinnabar	HgS	86.2	1,724	Principal source.
	Molybdenum				
Sulphide	Molybdenite	MoS_2	60.0	1,200	Nickel and cobalt are almost always associated.
	Nickel.				
Sulphide	Millerite	NiS	64.7	1,294	
Sulphide	Pentlandite	$(Fe, Ni)S$	22.0	440	
Arsenide	Niccolite	$NiAs$	43.9	878	
Sulphide	Linnaeite	$(Co, Ni)_3S_4$	28.9	578	Proportions variable. This amount calculated for ratio Co : Ni = 1 : 1.
Arsenide	Chloanthite	$NiAs_2$	28.1	562	Grades insensibly into smaltite, $CoAs_2$.
Sulpharsenide	Gersdorffite	$NiAsS$	35.4	708	
Sulphantimonide	Ullmannite	$NiSbS$	27.8	556	
Carbonate	Zaratite	$NiCO_3.2Ni(OH)_2+4H_2O$	46.8	936	
Silicate	Genthite	$2NiO.2MgO.3SiO_2.6H_2O$	22.6	452	*Röttisite*, found in Voigtland, may be essentially the same as this.
Silicate	Garnierite	$H_2(Ni,Mg)SiO_4+aq$	[35.5	710]	Proportions very variable. This amount calculated from highest analysis given by Dana.
Arsenate	Annabergite (nickel ocher)	$Ni_3As_2O_8+8H_2O$	29.4	588	The most important nickel ore is pyrrhotite, a sulphide of iron (mostly $Fe_{11}S_{12}$), which sometimes contains more than 5 per cent Ni.
	Palladium.				
Metallic	Native palladium	Pd	100.0	2,000	Always alloyed with Pt, Ir, and other metals.
	Platinum.				
Metallic	Native platinum	Pt	100.0	2,000	Occurs, however, only alloyed with from 10 to 30 per cent Fe, Ir, Os, and other metals.
	Quicksilver. (*See Mercury.*)				
	Silver.				
Metallic	Native silver	Ag	100.0	2,000	Usually alloyed with gold; sometimes with copper.
Antimonide	Dyscrasite	Ag_3Sb	72.9	1,458	Other proportions cause the content of silver to range from 63.9 per cent to 94.1 per cent.
		Ag_6Sb	84.3	1,686	
Sulphide	Argentite	Ag_2S	87.1	1,742	
Telluride	Hessite	Ag_2Te	62.3	1,246	Often contains gold.
Telluride	Petzite	$(Ag, Au)_2Te$	42.0	840	Calculated for ratio, Ag : Au = 3 : 1.
Sulphide	Stromeyerite	$(Ag, Cu)_2S$	53.1	1,062	
Telluride	Sylvanite	$(Au, Ag)Te_2$	13.4	268	Calculated for ratio, Ag : Au = 1 : 1.
Sulphantimonite	Pyrargyrite (dark red silver ore)	Ag_3SbS_3	59.9	1,198	
Sulpharsenite	Proustite (light red silver ore)	Ag_3AsS_3	65.4	1,308	
Sulphantimonite	Stephanite (brittle silver ore)	Ag_5SbS_4	68.5	1,370	
Sulpharsenite	Polybasite	Ag_9SbS_6	75.6	1,512	Copper always replaces some of the silver.
Chloride	Cerargyrite (horn silver)	$AgCl$	75.3	1,506	
Chlorobromide	Embolite	$Ag(Cl,Br)$	65.1	1,302	Proportions of Cl to Br vary and change the total of silver present.
Bromide	Bromyrite	$AgBr$	57.4	1,148	
Iodide	Iodyrite	AgI	46.0	920	
					Much silver is obtained from galena, and it also occurs in tetrahedrite, sphalerite, pyrite, chalcopyrite, chalcocite, and other minerals in quantities of economic importance.

Percentage of metal contained in ores of economic importance—Continued.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Radium.				
	Uranite (pitchblende)	U$_3$O$_8$ K$_2$O.UO$_3$.2UO$_3$.V$_2$O$_5$.3H$_2$O	...	......	Radium, polonium, and actinium are extracted in minute quantities from these ores, especially pitchblende.
	Thorium.				
	Monazite	(Ce,La,Di)PO$_4$, ThSiO$_4$(?)	ThO$_2$, 6.49	130	Amount of thoria varies up to about 15 per cent; **seems to occur as a silicate mechanically present in monazite.**
	Tin.				
Sulphide	Stannite (tin pyrites)	Cu$_2$S.FeS.SnS$_2$	27.5	550	Proportions vary.
Oxide	Cassiterite (stream tin, wood tin)	SnO$_2$	78.6	1,572	Principal ore.
	Tungsten.				
Tungstate	Wolframite	(Fe,Mn)WO$_4$	60.6	1,212	Grades into hubnerite, MnWO$_4$, with 60.7 per cent tungsten.
Tungstate	Scheelite	CaWO$_4$	63.4	1,268	
	Uranium.				
Oxide	Uraninite (pitchblende)	U$_3$O$_8$	84.9	1,698	Chief ore; chief source also of radium, etc.
Oxide	Gummite	UO$_3$.3H$_2$O	72.7	1,454	
	Vanadium.				
Vanadate	Vanadinite	3Pb$_3$V$_2$O$_8$ + PbCl$_2$	10.9	218	
Vanadate	Mottramite	(Pb,Cu)$_3$V$_2$O$_8$ + 2H$_2$(Pb,Cu)O$_2$	10.5	210	
	Zinc.				Zinc minerals often are associated with lead ores.
Sulphide	**Sphalerite (blende, black jack)**	ZnS	67.0	1,340	
Sulphide	Wurtzite	ZnS	67.0	1,340	
Oxide	Zincite	ZnO	80.3	1,606	
Oxide	**Franklinite**	(Fe,Zn,Mn)O.(Fe,Mn)$_2$O$_3$	[18.6	372]	Variable. Highest analysis recorded by Dana.
Carbonate	**Smithsonite**	ZnCO$_3$	52.0	1,040	
Carbonate	Hydrozincite	ZnCO$_3$.2Zn(OH)$_2$(?)	60.5	1,210	Composition is uncertain and analyses vary.
Silicate	Willemite	Zn$_2$SiO$_4$	58.6	1,172	
Silicate	Calamine	H$_2$Zn$_2$SiO$_5$	54.2	1,084	

CHAPTER II.

SUMMARY AND ANALYSIS OF RESULTS.

I.

GENERAL REVIEW OF THE MINING INDUSTRY.

The statistics for the mining industries relate to the operations at mines, quarries, and petroleum and natural-gas wells, and embrace all minerals that were produced in commercial quantities during the calendar year ending December 31, 1902. These statistics are summarized in the following table:

TABLE 1.—SUMMARY: 1902.

	Total	Coal.	Copper.	Gold and silver.	Iron ore	Lead and zinc ore.	Petroleum and natural gas.	Stone[1]	All other minerals.
Number of mines	151,516	5,996	144	2,992	525	559	134,177	5,764	1,069
Number of operators	46,458	4,528	144	2,992	332	557	31,180	5,470	1,346
Salaried officials, clerks, etc.:									
Number	38,128	17,427	1,208	3,480	2,405	910	4,956	5,279	2,463
Salaries	$39,020,552	$17,419,217	$1,768,456	$5,076,773	$2,213,230	$825,327	$4,797,105	$4,488,339	$2,531,105
Wage earners:									
Average number	581,728	350,329	26,007	35,142	38,851	7,981	22,230	71,156	29,132
Wages	$369,979,960	$220,198,401	$21,151,466	$26,077,492	$21,531,792	$4,329,271	$16,178,640	$37,515,907	$12,977,052
Contract work	$20,677,908	$1,670,831	$188,768	$626,090	$425,292	$106,607	$17,415,632	$36,991	$226,053
Miscellaneous expenses	$71,771,713	$26,081,698	$1,597,465	$5,357,829	$8,257,714	$2,092,001	$21,723,983	$3,976,865	$2,984,458
Cost of supplies and materials	$123,814,967	$37,569,702	$11,083,175	$16,099,708	$9,006,608	$2,511,657	$24,588,767	$10,739,736	$11,846,564
Value of products	$796,826,417	$367,032,069	$51,178,056	$82,182,052	$65,465,321	$14,600,177	$102,365,002	$70,162,438	$43,340,722

[1] Includes limestones and dolomites, marble, sandstones and quartzites, silica sand, siliceous crystalline rocks, and slate.

The differences in the extent to which the manufacturing processes have been included in the statistics of prior censuses interfere with the comparability of the results, but in the following table the quantities and values reported for the Eleventh and Twelfth censuses have been reduced as nearly as possible to a comparable basis, and therefore the totals for copper, gold and silver, and lead and zinc for 1902 do not agree with the figures shown elsewhere in this report. The inclusion of the refined products for gold, silver, and other metals in this table has increased the value of products to $892,505,619, an excess of $95,679,202 over the $796,826,417 reported as the value of the products of the mines, quarries, and petroleum and natural-gas wells.

TABLE 2.—COMPARATIVE STATEMENT, QUANTITIES AND VALUES OF MINERALS: 1902 AND 1889.

MINERAL.	Unit of measure.	1902		1889	
		Quantity.	Value.	Quantity.	Value.
Total			[1]$892,505,619		$444,012,998
Antimony	Short tons	(2)	(2)	265	28,000
Asbestos	Short tons	2,505	46,200	30	1,800
Asphaltum and bituminous rock	Short tons	66,238	236,728	51,735	171,537
Barytes	Short tons	61,668	203,154	21,460	106,313
Bauxite	Long tons	29,222	128,206	[3]21	97,335
Borax	Short tons	19,142	2,383,614	[4]1,000	[4]500,000
Buhrstones and millstones	Stones	6,667	59,808	(5)	35,155
Cement	Barrels	21,655,360	24,268,338	[4]7,000,000	[4]5,000,000
Clay	Short tons	1,435,357	2,061,072	[4]329,665	[4]665,578
Coal, anthracite	Long tons	36,940,710	76,173,586	40,714,721	65,879,514
Coal, bituminous	Short tons	260,216,844	290,858,483	95,629,026	94,346,809
Copper[6]	Pounds	629,036,302	71,192,024	231,246,214	26,907,809
Corundum and emery	Short tons	4,251	104,605	2,245	105,565
Crystalline quartz	Short tons	15,104	13,085	(5)	(5)
Feldspar	Short tons	45,287	250,424	[4]7,906	[4]39,570

[1] Exclusive of duplication of value of silver content of argentiferous iron ore, amounting to $885,987.
[2] No production from domestic ores.
[3] Aluminum, quantity reduced from 47,468 pounds.
[4] Not included as a part of the census, no statistics other than production reported.
[5] Not reported.
[6] Copper contents of all ores mined.

TABLE 2.—COMPARATIVE STATEMENT, QUANTITIES AND VALUES OF MINERALS: 1902 AND 1889—Continued.

MINERAL	Unit of measure	1902		1889	
		Quantity	Value	Quantity	Value
Flint	Short tons	36,365	144,209	[1]32,445	[1]89,437
Fluorspar	Short tons	48,818	275,682	9,500	45,835
Fuller's earth	Short tons	11,492	98,144	(2)	(2)
Garnet	Short tons	3,926	132,820	(2)	(2)
Gold, coining value[3]	Troy ounces	3,645,704	75,364,600	1,590,869	32,886,744
Graphite	Short tons	27,458	227,508	7,003	72,662
Grindstones and pulpstones	Short tons	56,657	667,431	(2)	439,587
Gypsum	Short tons	681,658	2,089,341	267,769	764,118
Infusorial earth, tripoli, and pumice	Short tons	6,435	65,994	3,466	23,372
Iron ore	Long tons	[4]35,567,410	[4]65,465,321	14,518,041	33,351,978
Lead[5]	Short tons	258,125	18,181,013	181,131	6,467,137
Limestones and dolomites			20,441,801		19,095,179
Lithium ore	Short tons	1,245	25,750	(2)	(2)
Lithographic stone	Short tons	(6)	(6)	18	243
Manganese ore	Long tons	16,477	177,911	24,197	240,559
Marble			5,044,182		3,488,170
Marl	Short tons	12,439	12,741	[1]96,206	63,956
Mica:					
Sheet	Pounds	373,266	118,849	49,500	52,450
Scrap and waste	Short tons	1,400		196	
Mineral pigments, crude	Short tons	35,479	540,888	[7]38,184	[7]482,766
Monazite	Pounds	802,000	64,160	(2)	(2)
Natural gas			30,867,863		21,097,099
Oilstones, whetstones, and scythestones	Short tons	3,870	115,968	2,994	32,980
Ozocerite, refined	Pounds	(6)	(6)	50,000	2,500
Petroleum	Barrels	89,275,302	71,397,730	35,163,513	26,963,340
Phosphate rock	Long tons	1,548,720	4,922,943	550,245	2,937,776
Platinum and iridium	Troy ounces	[8]94	[8]1,814	500	2,000
Precious stones			328,450		188,807
Quicksilver:					
Crude	Short tons	11,727	1,500,000	2,750	(2)
Refined	Flasks	34,291		26,484	1,190,500
Sandstones and quartzites			10,601,171		12,065,676
Silica sand	Short tons	445,900	421,289	(6)	(2)
Siliceous crystalline rocks			18,257,944		14,464,095
Silver, coining value[9]	Troy ounces	[4]55,911,916	[4]71,077,562	51,354,851	66,396,988
Slate			5,690,051		3,482,513
Sulphur and pyrite	Short tons	232,819	947,089	106,100	209,969
Talc and soapstone	Short tons	97,563	1,138,167	36,461	475,878
Tungsten	Short tons	184	5,975	(2)	(2)
Uranium and vanadium	Short tons	3,810	48,125	(2)	(2)
Zinc ore[10]	Short tons	527,121	9,065,351	234,503	3,049,790
All other minerals[11]	Short tons	3,536	49,256	3,151	73,000

[1] Not included as a part of the census; no statistics other than production reported.
[2] Not reported.
[3] Fine gold contents of auriferous ores and placer bullion.
[4] Silver content of argentiferous iron ore—1,021,602 troy ounces valued at $883,987, included in both iron ore and silver.
[5] Nonargentiferous lead ore and lead contents of argentiferous and copper ores.
[6] No production.
[7] Includes slate ground as a pigment, 2,000 long tons, value $20,000.
[8] Platinum only; entire production obtained in placer mining and the refining of auriferous ores.
[9] Fine silver contents of argentiferous ores and placer bullion.
[10] Zinc ore and zinc contents of auriferous and argentiferous ores.
[11] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile for 1902, and chrome ore, nickel and cobalt, and rutile for 1889.

The reports for each census, beginning with 1850, have included statistics for mines and quarries, but prior to the census of 1870 these statistics are so interwoven with those for manufactures that it is impossible to make a satisfactory segregation. At the censuses of 1870 and 1880 the canvass for the collection of mining statistics was so defective that the results can not be used for general comparisons to show the increase in all branches of mining. A complete canvass was made at the Eleventh Census, which covered the year 1889, but the results were not summarized nor were the data, except for the quantity and value of products, compiled on uniform lines.

The only information concerning the employees, wages, and other expenses for all branches of mining published at the Eleventh Census is contained in the following statement taken from the text of the report: "In all, 636,419 persons found employment directly in the mining industry, and depended upon this industry as their regular means of support. They received in wages $265,290,643, or more than 52 per cent of the entire value of what they produced. In addition, the other expenditures aggregated $115,874,135."[1] In 1902 there were 38,128 salaried officials, clerks, etc., with salaries amounting to $39,020,552. The average number of wage-earners employed during the entire year was 581,728, and they received in wages $369,959,960. The miscellaneous expenses and cost of supplies and materials amounted to $195,586,680, and the products were valued at $796,826,417. The products reported for 1889 amounted to $587,230,662,[1] but they include salt, pig iron, and other substances omitted from the mining census of 1902. Reducing the production to a comparative basis, as shown in Table 1, by including for 1902 the value of refined copper, the coining value of gold and silver, and the lead and zinc contents of argentiferous ores, and eliminating from 1889 the products not included in the

[1] Eleventh Census, Report on Mineral Industries, page xi.

mining census of 1902, the total for 1889 becomes $444,012,998, as compared with $892,505,619 for 1902, an increase of $448,492,621, or 101 per cent. The number of persons who found employment directly in the mining industries at the Eleventh Census was evidently reported on a different basis from that used at this census. The average number shown for 1889 was the average number employed during the time the mine was in operation, while the average number shown for 1902 is the average number for the whole year, whether the mine was in operation all the year round or a part of the time only. The value of products reported for the census of 1902 is the amount received by the mine operators, and should not be confused with the value of the finished mineral product or the refined metallic contents of the ore, such as iron, antimony, and nickel. The quantity and value of the refined metallic contents and the coining value of some ores, such as gold and silver, are given for 1902 in Table 1 in order to obtain comparable totals. The separate quantity and value of gold, silver, copper, lead, or zinc, when, as frequently happens, two or more of them are obtained from the same ore, can not be definitely determined until the ore has been smelted. Smelting is a manufacturing process, and is therefore omitted from the mining census, but the metallic content of the ore and bullion produced in continental United States during the year 1902 and the gross value of the same, as computed from the reports to the Bureau of the Census, were as follows: Gold, 3,242,039 ounces, valued at $65,628,906; silver, 55,819,946 ounces, valued at $28,166,094; copper, 639,023,392 pounds, valued at $71,192,014; lead, 338,125 short tons, valued at $18,181,013; zinc, 527,121 short tons, valued at $9,006,361. These values are the values at the mines. Gold and silver were reported at the Eleventh Census in troy ounces and coining value. Computed on the same basis, the production of continental United States for 1902 amounted to 3,242,039 ounces of gold, valued at $67,018,890, and 55,819,946 ounces of silver, valued at $72,171,227. No canvass of the gold mines of Alaska having been made by the Bureau of the Census, the estimate for Alaska made by the Director of the Mint is accepted by this office. The total production of the United States for 1902 is accordingly estimated as follows: Gold, 3,645,769 ounces, valued at $75,364,690; silver, 55,911,946 ounces, valued at $72,290,176. The Director of the Mint reports the production of gold for the United States for the calendar year 1902 as 3,870,000 ounces, valued at $80,000,000, and the production of silver as 55,500,000 ounces, valued at $71,757,575. The disparity in these results is due to the fact that the Bureau of the Census collected the data directly from the mines, while the Director of the Mint obtained the information from mints, assay offices, private refineries, and other sources. The quantities and values reported by the Director of the Mint represented the refined product, a portion of which may have been mined during the preceding year; and, moreover, since a portion of the product reported by the Bureau of the Census as mined during 1902 would be included in the report of the Director of the Mint for the following year, the totals for the two offices for the same year can not agree.

The increase that has occurred in the production of the different minerals during the thirteen years covered by Table 2 is referred to in the discussion of the statistics for each mineral on pages 393 to 1071. Reference should be made to these separate reports for more detailed information.

As no statistics for employees, wages, or expenses incident to the production of cement, clay, feldspar, flint, rutile, borax, or slate ground as a pigment are given in the report of the Eleventh Census, it was necessary to take the production for these minerals for 1889, as shown in Table 2, from the tabulation of the mineral products of the United States, apparently prepared, in some respects, independently of the regular census work, but presented in the introduction to the report.

The Eleventh Census did not present statistics of any character for bauxite, crystalline quartz, fuller's earth, lithium ore, magnesite, molybdenum, monazite, tungsten, or uranium and vanadium, these minerals not then being produced in commercial quantities. Silica sand which is usually the product of sandstone quarries was included under the classification of sandstones, while garnet was included in abrasives.

Decreases in 1902.—A decrease is shown in the production of minerals in 10 classifications enumerated in Table 2. The quantities and values of these are reproduced in the following statement:

Minerals showing a decrease in production in 1902.

MINERAL.	1902		1889	
	Short tons.	Value.	Short tons.	Value.
Antimony	......	...	265	$28,000
Corundum and emery	1,251	$104,605	2,245	105,565
Lithographic stone			18	243
Manganese ore	[1]16,477	177,911	[1]24,197	240,559
Marl	12,439	12,741	136,295	63,956
Mineral pigments, crude	35,479	460,885	36,184	463,766
Ozocerite	....	....	25	2,500
All other minerals[2]	140	14,617	3,151	73,000

[1] Long tons.
[2] Includes chrome ore, nickel and cobalt, and rutile.

There was no production of antimony in 1902 from domestic antimony ores, the entire product being obtained from the smelting of domestic hard lead ores, or from imported regulus or metal, and antimony ores. Antimony has not yet been uncovered in any of the states in sufficient quantity for development. The known deposits of the mineral are associated with other metals that so predominate as to prohibit the exploitation of antimony as such.

While there was a slight decrease in the value of corundum and emery produced in 1902 as compared with 1889, a great increase occurred in the tonnage. The average price per ton of the product decreased during the period of thirteen years nearly one-half. The manufacture of an artificial abrasive as a substitute for corundum and emery has had its effect upon the value of the natural material.

There was no production of lithographic stone in the United States during 1902, no beds having been found that furnished stone of sufficient purity or adequate size. The substitution of plates of zinc and other metals, and the importation of lithographic stone, principally from Bavaria, satisfied the demand.

The deposits of manganese ore found in the United States are combined with siliceous and phosphorous substances to such an extent that the production can not compete with the foreign ore. Moreover, the deposits are located in isolated places, where transportation facilities are inadequate. These disadvantages have resulted in a decrease in the production of domestic manganese ore as compared with the production of 1889, although the product in 1902 was the largest since 1891.

The decrease in the production of marl is due to the greater substitution since 1889 of fertilizers made of phosphate rock and other materials. About two-thirds of the production of 1902 was obtained from New Jersey and was consumed locally.

The indicated decrease in the production and value of crude mineral pigments is more apparent than real. The statistics for 1902 are to a considerable extent for the crude product, while the production shown for 1889 included the value of large quantities of refined material or manufactured paint. As a matter of fact, the mining of mineral pigments is progressing steadily.

Ozocerite (native paraffin), or a mineral closely related to it, was reported some years ago to have been found in Utah, but according to the report it could not be produced continuously in commercial quantities because it could not compete with the ozocerite imported from Austria. This Utah ozocerite constituted the production reported in 1889. It is said now to be exhausted. "Immense quantities are extracted from the crude petroleum found in the Pennsylvania and Lima (Ohio) fields."[1] This, as paraffin wax, is included in the products of petroleum refining.

The group of "all other minerals" shown in the above statement, includes chrome ore, nickel and cobalt, and rutile, but as there were only two operators reported for nickel and cobalt and one each for chrome ore and rutile, the production of the different minerals can not be shown without disclosing the operations of individual operators. All of these minerals show a decrease when compared with the production of 1889. Many deposits of chrome ore can not be mined on account of the low price at which the foreign ore is imported. There are only a few nickel ore deposits in the United States, and these can not be worked to advantage at the prices prevailing for refined nickel, and in competition with the more profitably worked nickel ore deposits of Canada. Cobalt is closely associated with the nickel in the ores from which these metals are obtained. A small production of rutile satisfies the demand. The quantity has increased, but there has been a large falling off in the value of the total product mined.

Early development.—Mining was not an important feature of the early development of the United States, and until comparatively recent years information concerning the mineral products of the country was very meager. Agriculture was the predominating industry of the entire country at the opening of the nineteenth century; later, manufactures received greatest attention in the Northern and agriculture in the Southern and Western states. Numerous exploring expeditions were conducted during the early history of the country for the purpose of locating mineral deposits. Reference is made in the reports of these expeditions, to the mineral deposits in the region of the Great Lakes and the Mississippi valley. "During the eighteenth century a number of mining operations were undertaken and carried on in different parts of the country, apparently with but little success."[2]

The history of coal mining in the United States affords a good illustration of the general development of the mining industry. In 1820 the first cargo of anthracite coal was sent to Philadelphia. The annual consumption of all coal in 1847 has been estimated at 3,000,000 tons;[2] in 1902 the production of anthracite coal amounted to 41,373,595 short tons and the production of bituminous coal to 260,216,844 short tons, making the total production 301,590,439 short tons.

The smelting of iron ore appears to have been carried on to some extent in Massachusetts as early as 1702.[3] The production of iron ore in 1840 has been estimated at more than 300,000 tons, and the production of pig iron from the ore in Pennsylvania amounted to 98,395 tons.[4] The Lake Superior region was opened in 1844 and about 800 tons of blooms were shipped from the region in 1853.[5] In 1902 the production of iron ore in Pennsylvania amounted to 822,932 long tons and in the Lake Superior region to 26,977,404 long tons, the production of the two districts amounting to 27,800,336 long tons, or 78.2 per cent of the 35,567,410 long tons reported for the United States.

Early in the nineteenth century gold was mined to some extent in North Carolina, and for a number of years following 1829 considerable quantities were produced throughout the Southern states. But few attempts at regular mining were made prior to 1834.[1] The discovery of gold deposits in California in 1848 gave an impetus not only to the search for precious metals, but also to mining enterprises of all kinds throughout the country.[2] The production of domestic gold in 1853 deposited at the United States Mint and its branches was valued at $55,622,051, $55,113,487 of which value was obtained from California.[3] The production for 1902, as reported by the Director of the Mint, was valued at $80,000,000.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 596.

[2] The Metallic Wealth of the United States, by J. D. Whitney, page xxiii.

[3] Ibid., page 460.

[4] Ibid., pages 472 and 487.

[5] Ibid., page 478.

Operations in the copper region of Lake Superior began as early as 1771, but particular attention was not directed to that field until 1844.[4] Its production of pure copper for 1854 has been estimated at 2,000 tons.[5] The production of the same region in 1902 was 171,102,065 pounds, or 26.8 per cent of the 639,033,392 pounds reported for the United States.

Mining in the Missouri lead field appears to have begun as early as 1720, but was not followed in a regular manner until 1798. By act of Congress of March 3, 1807, all the government lands containing lead were ordered to be withheld from sale, and leases were authorized instead. The issuing of leases began in 1822. After 1834 smelters and miners refused to make payments because of the great number of illegal entries of mineral land, and in 1847 Congress authorized the Land Office to sell the lands outright. In 1839 a geological survey of the lead region of the upper Mississippi valley was authorized by Congress. In 1840 the production of the upper Mississippi and Missouri regions was estimated at 14,780 tons.[6] In 1902 these regions produced 131,606 tons. The greater part of the lead product of the United States in 1902 was obtained from argentiferous ores. The history and occurrence of the various minerals in the different states are referred to in the discussion of the statistics for each state, on pages 163 to 346.

The importance of the mining industries is due not only to the magnitude of the aggregate production, but also to the great number of different minerals mined and the numerous uses to which they are applied. The development of these industries has occurred very largely since 1880, as many of the minerals enumerated in this report were not mined in commercial quantities before that year. Exclusive of coal, pig iron, copper, lead, petroleum and natural gas, stone, quicksilver, limestone for iron flux, zinc, and the precious metals, the mineral products of the country in 1880, as reported by the Geological Survey, were valued at only $37,567,133. The corresponding value for 1902 was $82,395,444—an increase of $44,828,311, or 119.3 per cent. The existing diversity of metals is largely the result of processes applied to the reduction of the minor metalliferous minerals; while the great absolute increase in quantity and value of mining products, in number of people employed and in yearly wages paid, is due mainly to the development of the major minerals, the great variety of uses to which the minor ores and the metals derived from them can be put has furnished a constant incentive to increase their production.

Table 8 presents statistics for 52 classifications of minerals. From these, however, there are obtained a large number of metals and other substances, each distinct in character, as the result of processes applied directly to the mineral or ore. There are also a multitude of other substances obtained by their use as bases for chemical combinations and manufacturing processes.

The organization of the United States Geological Survey in 1879 was the first step in the scientific investigation of the mineral deposits of the country as a whole. The general desire for information concerning the mineral resources of the country has been satisfied in part by systematic geological investigations in several of the states, beginning as early as 1823. At a still earlier period investigations were carried on by private enterprise, generally limited to minerals of well-known market value, such as iron, gold, silver, copper, and coal. The need for information concerning the location, character, and extent of the deposits of these minerals was fully appreciated by the organizers of the Geological Survey, and it is evident from the estimate submitted to Congress for the work of the office for the fiscal year ending June 30, 1881—the second year of the Survey's existence—that exhaustive preparations were made for the collection of information concerning all classes of minerals and the geological structure of the entire country.[7]

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[1] The Metallic Wealth of the United States, by J. D. Whitney, pages xxiv and xxv.

[2] Ibid., pages xxvi and 135.

[3] Ibid., page 145.

[4] Ibid., pages 247, 249, and 305.

[5] Ibid., pages 247, 249, and 421.

[6] Ibid., pages 405, 417, and 421.

[7] *Estimates of appropriations required for the service of the fiscal year ending June 30, 1881.*

Geological survey of iron and coal resources of public domain	$30,000
Extending observations on coal and iron into old states	20,000
Survey of agricultural geology on public lands of Mississippi basin	25,000
Extending observations on agricultural geology into old states	10,000
Geological survey of gold and silver in division of Rocky mountains	35,000
Geological survey of gold and silver in division of Great basin	35,000
Geological survey of gold and silver in division of Pacific	35,000
Survey of geological structure and classification of public lands in Mississippi basin	25,000
Survey of geological structure and classification of public lands in Rocky mountains	30,000
Survey of geological structure and classification of public lands in Colorado basin	40,000
Survey of geological structure and classification of public lands in Great basin	30,000
Survey of geological structure and classification of public lands in [division of] Pacific	25,000
	340,000

[Executive Documents, Forty-sixth Congress, second session, 1879-80, Vol. 15, No. 5, page 174.]

Rank of the United States in mining.—The United States holds first place in the production of most of the minerals and it is preeminent in the production of five of the great minerals that are the basis of manufactures—i. e., coal, iron, copper, lead, and gold. In the production of silver it is outranked by Mexico only. The quantities of these minerals, as far as they can be ascertained, for the principal producing countries, are given in the following table:

TABLE 3.—*Production of coal, iron ore, copper, lead, gold, and silver in the principal producing countries: 1902.*

COUNTRY.	Coal (short tons).	Iron ore (long tons).	Copper, refined[1] (long tons).	Lead, smelted[2] (short tons).	Gold[3] (fine ounces).	Silver[3] (fine ounces).
United States	301,590,439	35,567,410	294,423	377,061	3,870,000	55,500,000
Africa					1,887,773	
Australia			18,284	99,207	3,416,002	8,026,037
Austria	[4]45,417,959	[5]3,396,270				
Belgium	[4]24,485,842					
Bolivia						12,992,641
Canada			17,486		1,003,355	4,300,774
Chile			28,930			3,066,792
France	33,286,146	[4]4,715,021				
Germany	165,826,496	[6]17,679,707	21,606	154,658		6,722,641
Great Britain	254,346,447	[4]12,275,198		29,872		
Italy				29,101		
Japan			29,775			
Mexico			40,785	112,435		[7]60,176,604
Peru						4,264,528
Russia	[4]17,934,201	[4]6,905,179			1,090,058	
Spain		[4]7,781,566	[8]49,790	199,816		3,700,189
Sweden		2,850,839				

[1] Circular of Henry R. Merton & Co. (Limited), cited in report of the United States Geological Survey, "Mineral Resources of the United States," 1902, pages 198 and 199.

[2] "Comparative Statistics of Lead, Copper, etc.," compiled by the Metallgesellschaft and Metallurgische Gesellschaft, A.-G., Frankfort-on-the-Main, 1903, page 2, except for the United States, which is from the United States Geological Survey, "Mineral Resources of the United States," 1902.

[3] Treasury Annual Reports, 1903, "Production of the Precious Metals," 1902, page 351.

[4] Statistics for 1901, those for iron ore in Russia estimated.

[5] Includes Bosnia and Herzegovina.

[6] Includes Luxemburg, in Belgium.

[7] Estimated as being equal to the amount of silver coined and exported; coin exports omitted.

[8] Includes Portugal.

The position of the United States as the nation of first importance in the principal mining industries is so evident from an examination of Table 3 that further illustration is unnecessary. This position is due to the development of the vast mineral deposits in the United States, many of them practically unlimited; to improved mining methods and machinery; to the development and improvement of transportation facilities; and to the stimulus given the mining and quarrying industry by the increase of manufacturing and building in the country during the past twenty-five years. If a country be regarded as having natural resources of a given extent and character, it follows that an increase in the annual production of minerals in the country must result from one or both of two causes—increase in the number of productive laborers, and improvement of their productive power. Both of these causes have been operative in the United States in a very high degree as a result of the favoring industrial conditions that have obtained during the greater part of the last quarter of a century.

The use of the steam shovel in open-cut mining, the application of electricity and chemical methods and processes to all branches of mining, and of automatic machinery to the drilling and cutting of the rock and ore have been the principal improvements in the productive power of labor. The rates of wages which, as a rule, have prevailed in the mining industries have kept the supply of labor adequate to the demand, and, with a few notable exceptions, due to labor disturbances, strikes, or lockouts, there has been a constant increase in both the productive power and the quantity of labor.

Except in the case of the leading minerals enumerated in Table 3, there has been no systematic collection of statistics in all producing countries that would permit an authentic showing of the rank of each in the production of all classes of minerals. In the absence of such information, the estimates of Mr. Michael G. Mulhall are given as follows:

> In point of value no country approaches the United States, but in weight of mineral Great Britain is ahead. It may be said, as regards weight, that Great Britain raises one-third, the United States one-third, and all other nations collectively one-third of the minerals of the world. The weight and value of minerals and the number of miners in 1894 were [value reduced to dollars at $4.80 the pound, Mulhall having fixed that rate in reducing the dollars to pounds]:
>
> | COUNTRY. | Million tons | Million dollars. | Miners. | Dollars per miner. | Tons per miner. |
> |---|---|---|---|---|---|
> | Total | 746 | 1,449 | 3,130,000 | 463 | 240 |
> | Great Britain | 240 | 374 | 840,000 | 446 | 285 |
> | United States | 230 | 451 | 580,000 | 778 | [1]400 |
> | Germany | 115 | 163 | 400,000 | 408 | 287 |
> | France | 38 | 77 | 180,000 | 427 | 210 |
> | Other countries | 123 | 384 | 1,130,000 | 340 | 110 |
>
> [1] The exact number of miners is not known. * * * The rates in 1890 were even higher, viz, 440 tons per miner.
>
> The money value of product per miner is higher in Great Britain than among other European nations, but is greatly surpassed by the ratio in the United States, perhaps because in the latter country the difficulties of extraction are less.[1]

Mr. Mulhall states further that coal is the great lever of industrial progress and constitutes 70 per cent of the total mineral production of all nations; also that the production has grown thirtyfold since 1820,[2] the showing for the two years for the leading nations being as follows:

COUNTRY.	1820	1894
Total	17,200,000	531,000,000
Great Britain, tons	12,500,000	188,300,000
United States, tons	500,000	152,500,000
Germany, tons	1,500,000	99,000,000
Other countries, tons	2,700,000	91,200,000

The production of coal in the United States in 1902 was 301,590,439 short tons, exceeding that of Great Britain by 47,243,992 tons. In the production of iron ore Mr. Mulhall gives the United States first rank in 1894, with a production of 17,000,000 tons, as compared with 12,400,000 tons for Great Britain and Germany, respectively, which shared the second place.[1] He gives the United States the third place in 1894 in the production of gold, and the second place in the production of silver, assigning the first place to Spanish America, with a production valued at £9,900,000, as compared with £6,400,000 for the United States.[2] The production of pig iron in the United States in 1901 was 15,878,354 gross tons, as compared with 7,928,647 gross tons in Great Britain and 7,736,663 gross tons in Germany, the production of the United States thus exceeding the combined production of the two countries by 213,044 gross tons. The statistics of 1902 for Great Britain and Germany are not available, and therefore no comparative figures for that year can be given. The production of silver in the United States in 1902 was valued at $71,757,600 (coining value), as compared with $108,343,000 for Spanish America.

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[1] Industries and Wealth of Nations, by Michael G. Mulhall, edition of 1896, pages 34 and 35.

[2] Ibid., page 35.

Increase since 1880.—The following table shows the relative increase in population and in value of manufactures, agricultural products, and mineral products since 1880, as shown in the Tenth, Eleventh, and Twelfth censuses:

TABLE 4.—INCREASE IN POPULATION AND IN VALUE OF AGRICULTURAL PRODUCTS, MANUFACTURES, AND MINERAL PRODUCTS: 1880 TO 1900.[1]

YEAR.	Population.	Agricultural products.	Manufactures.	Mineral products.	PER CENT OF INCREASE.			
					Population.	Agriculture.	Manufactures.	Mining.
1900	76,149,386	$4,717,078,121	$13,014,287,498	[2]$796,826,417	20.9	91.7	38.9	94.0
1890	62,979,766	2,460,107,454	9,372,437,283	410,760,770	25.6	11.2	74.5	63.0
1880	50,155,783	2,212,540,927	5,369,579,191	251,965,000				

[1] Exclusive of Hawaii.

[2] For the calendar year 1902.

While the comparison of the population and of manufactures and agriculture in Table 4 is limited to twenty years and of mining industries to twenty-three years, it covers a period that has been quite remarkable for the development of the mining industries. The value of the mineral products increased for the whole period 216.2 per cent, as compared with an increase of 51.8 per cent for population, 142.4 per cent for manufactures, and 113.2 per cent for agriculture. In 1880 for every dollar of mineral products there were $21 of manufactures and $9 of agricultural products. In 1900 the ratios were $16 and $6 for manufactures and agriculture, respectively, to $1 for mineral products. In 1880 the per capita values of the products of manufactures, agriculture, and mining were $107, $44, and $5, respectively. By 1900 these values had increased to $171, $62, and $10, respectively.

In the absence of annual census data, yearly totals, as compiled by the United States Geological Survey, are presented in Table 5, to show the annual growth of the various industries. These totals include value of product for salt, pig iron, bromine, refined gold and silver, zinc white, and other manufactured products not taken at the census of 1902, as well as mineral waters which are not the product of regular mining operations as defined by the Bureau of the Census.

TABLE 5.—*Mineral products: 1892 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Total.	Value of nonmetallic mineral products.	Value of metallic products.	Estimated value of mineral products unspecified.
1902	$1,260,639,415	$617,380,831	$642,258,584	$1,000,000
1901	1,086,584,851	567,318,722	518,266,129	1,000,000
1900	1,063,678,053	512,252,767	550,425,286	1,000,000
1899	972,208,008	445,428,451	525,779,557	1,000,000
1898	698,566,788	353,848,530	343,718,258	1,000,000
1897	631,237,074	327,705,927	302,531,147	1,000,000
1896	622,814,265	333,954,110	287,860,155	1,000,000
1895	620,652,170	338,172,239	281,479,931	1,000,000
1894	527,079,279	307,714,785	218,364,494	1,000,000
1893	574,464,721	323,257,018	250,207,703	1,000,000
1892	648,895,031	339,958,842	307,936,189	1,000,000

With the exception of the two years from the close of 1892 to the close of 1894, there has been a yearly increase in the value of product. The average annual increase during the past eight years has been $91,695,017. It will be noted that the production for 1902 exceeds by $463,812,998 the $796,826,417 reported by the census as the value of the products of mines, quarries, and petroleum and natural-gas wells. This excess is explained almost entirely by the difference between the value of the crude ore and the value of the metals smelted and refined from them, such as iron, gold and silver, copper, and lead and zinc. Thus, the ore classed as copper ore by the census method was valued at $51,178,036, while the value of the refined copper contents of all ores as reported by the Survey was $76,568,954. Again, the

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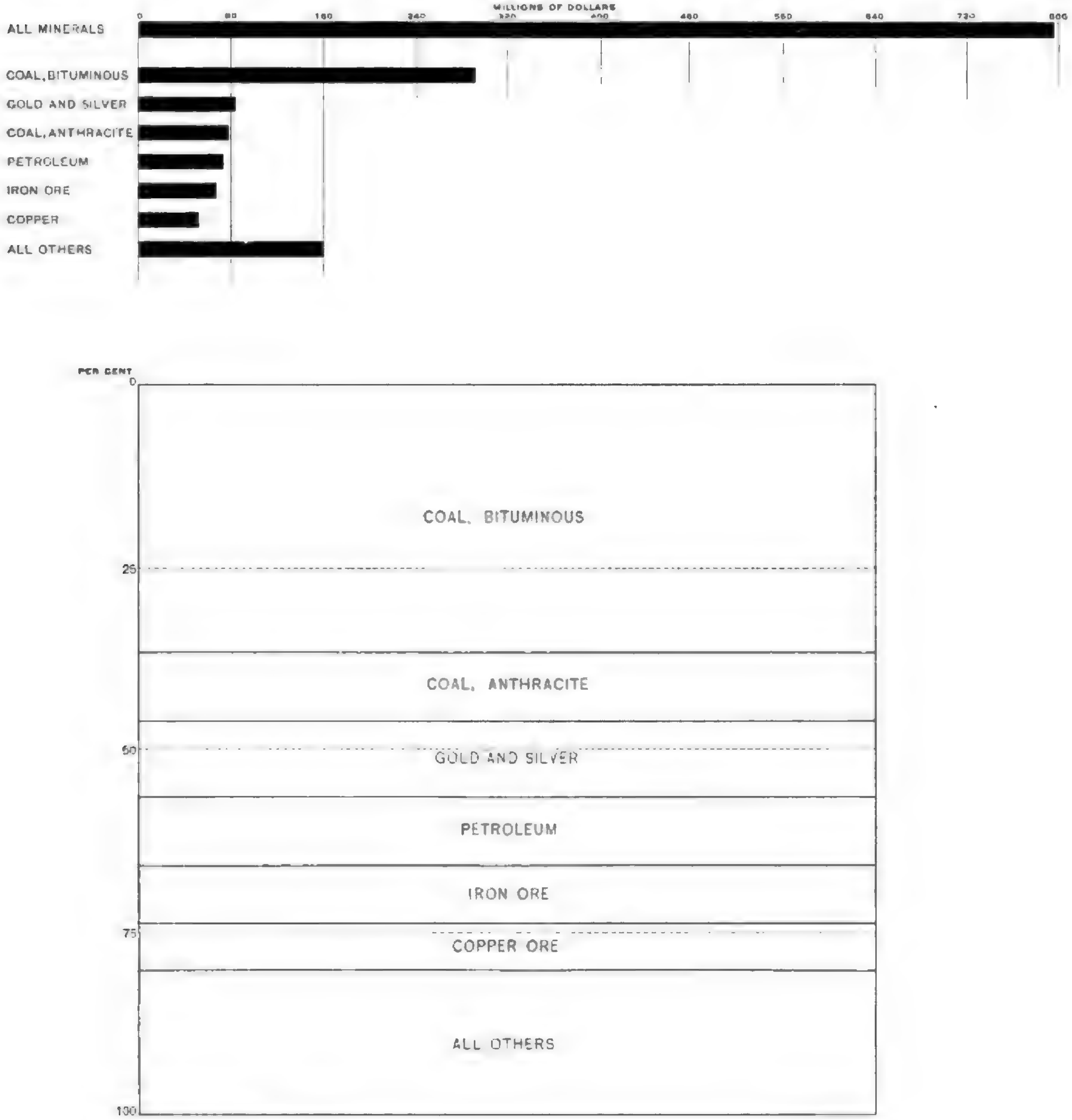
[1] Industries and Wealth of Nations, by Michael G. Mulhall, edition of 1896, page 35.

[2] Ibid., page 36.

DIAGRAM 1.—VALUE OF PRODUCTS OF PRINCIPAL MINERALS AND PROPORTION EACH BEARS TO TOTAL: 1902



value of the gold and silver as reported by the Bureau of the Census was $82,482,052 at the mine, these figures being exclusive of Alaska; but the coining value of the gold and silver reported by the Survey amounted to $151,757,575, and, in addition, platinum to the value of $1,814 was obtained. The Bureau of the Census reported iron ore valued at $65,465,321; the Survey placed in its totals for mineral products the value of the pig iron made in 1902, $372,775,000. The lead and zinc ores were valued by the Bureau of the Census at $14,600,177; the value of the refined metal was reported by the Survey at $36,765,596. These differences are explained in detail in the report for the several minerals.

Leading minerals.—While a great variety of minerals are included in the $796,826,417 reported as the value of the mining products at the Twelfth Census, the production of a few of the leading ones, such as coal, iron, copper, lead and zinc, petroleum and natural gas, and the precious metals, constitutes a large percentage of the total, and the great growth in the mining of these has been the principal cause of the increase in the number of people employed and in the value of products. The comparative importance of the principal minerals, as determined by the percentage that the totals for each form of the aggregates for the United States, is shown in the following table:

TABLE 6.—SUMMARY FOR LEADING MINERALS, AND PERCENTAGE EACH FORMED OF TOTAL: 1902.

	Number of mines, quarries, and wells.	Number of operators.	WAGE-EARNERS.		Supplies and materials, and miscellaneous expenses.	Value of product.
			Average number.	Wages.		
All minerals	151,516	46,858	581,728	$369,959,960	$195,586,680	$796,826,417
Coal, anthracite and bituminous	5,986	4,528	350,329	$220,198,401	$63,621,400	$367,032,069
Per cent of total	3.9	9.6	60.2	59.5	32.5	46.1
Copper ore	141	141	26,107	$21,151,105	$12,480,640	$51,178,036
Per cent of total	0.1	0.3	4.5	5.7	6.4	6.4
Gold and silver	2,992	2,992	36,142	$36,077,492	$22,057,297	$82,482,052
Per cent of total	2.0	6.4	6.2	9.8	11.3	10.4
Iron ore	525	332	38,851	$21,531,792	$17,263,322	$65,465,321
Per cent of total	0.3	0.7	6.7	5.8	8.8	8.2
Lead and zinc ore	580	557	7,881	$4,520,271	$4,643,688	$14,600,177
Per cent of total	0.4	1.2	1.4	1.2	2.4	1.8
Petroleum and natural gas	134,477	31,489	22,290	$16,178,640	$46,112,730	$102,255,062
Per cent of total	88.8	67.2	3.8	4.4	23.6	12.8
Stone[1]	5,764	5,470	71,156	$37,515,907	$14,716,602	$70,462,138
Per cent of total	3.8	11.7	12.2	10.1	7.5	8.8
All other minerals	1,069	1,346	29,132	$12,977,052	$14,731,002	$48,540,722
Per cent of total	0.7	2.9	5.0	3.5	7.5	6.1

[1] Includes limestones and dolomites, marble, sandstones and quartzites, siliceous crystalline rocks, slate, and silica sand.

The mining of the seven groups of leading minerals shown separately gave employment to 95 per cent of the wage-earners, and their production formed 94.6 per cent of the total production.

Less than one-tenth of the mine operators of the country were engaged in the production of ores, and their mines gave employment to less than one-fourth of the wage-earners, the value of their product being less than one-third of the total value of products.

To assist in a further analysis of the totals, and to show the concentration in certain lines of production, the statistics have been grouped according to the character of the minerals and of the metals obtained from the ore or the uses made of them. The classification of this character, made in the annual reports of the Geological Survey on the mineral resources of the United States, has, for the purpose of uniformity, been adopted by the Bureau of the Census.

A comparatively small proportion of the mineral products of the country can be classed as metalliferous, much the larger proportion consisting of coal, petroleum, natural gas, stone, borax, gypsum, phosphate rock, and other substances not of a metallic nature. In the following table the statistics are segregated so as to show the totals for metallic and nonmetallic substances:

TABLE 7.—*Summary for metallic and nonmetallic products: 1902.*

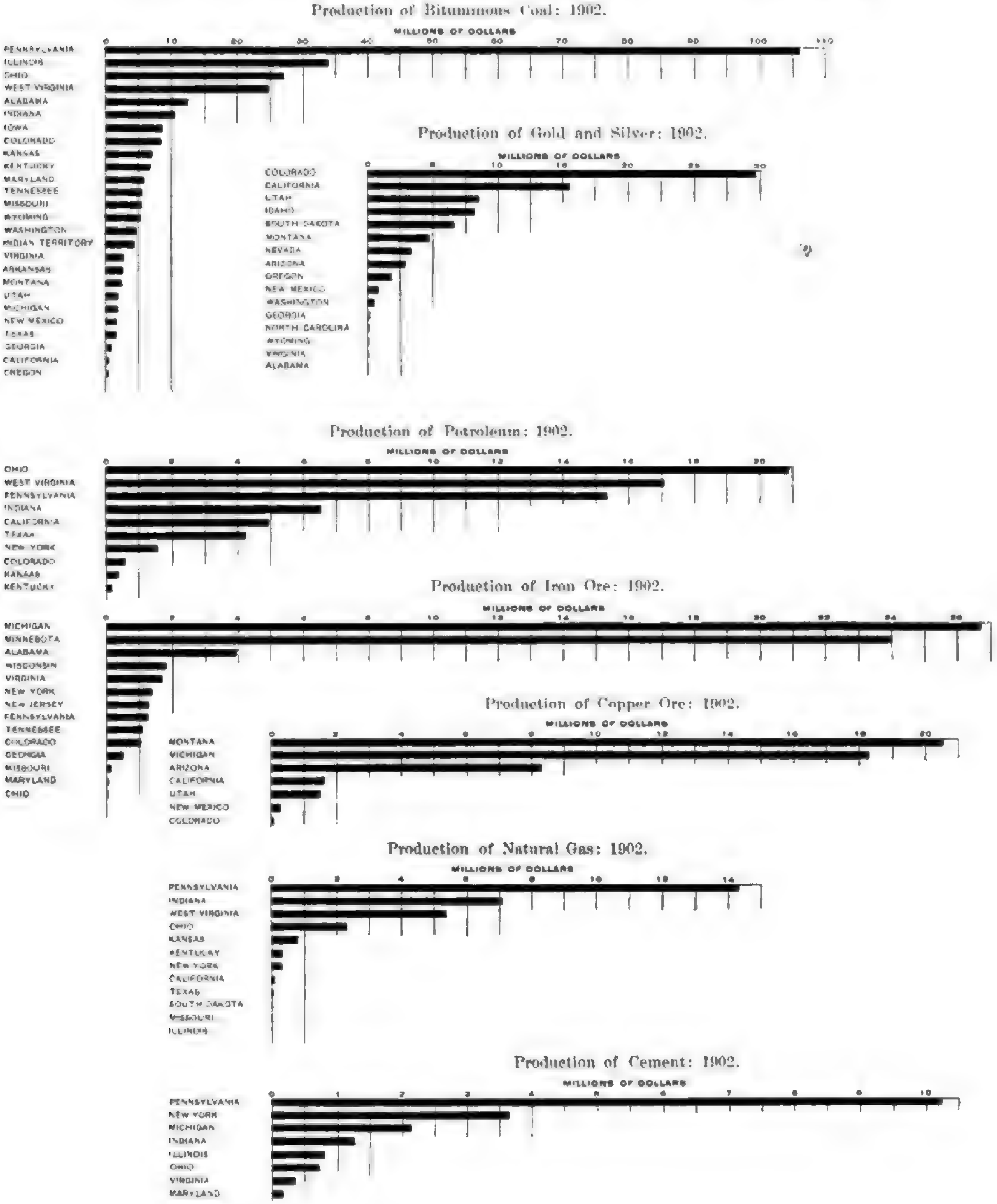
	Total.	Metallic.	Nonmetallic.
Number of mines	151,516	4,280	147,236
Number of operators	46,858	4,081	42,777
Salaried officials, clerks, etc.:			
Number	38,128	8,138	29,990
Salaries	$30,020,552	$9,948,335	$20,072,217
Wage-earners:			
Average number	581,728	110,404	471,324
Wages	$369,959,960	$84,046,223	$285,913,737
Contract work	$20,677,938	$1,371,921	$19,306,017
Miscellaneous expenses	$71,771,713	$17,168,321	$54,603,392
Cost of supplies and materials	$123,814,967	$39,639,703	$84,175,264
Value of product	$796,826,417	$215,153,587	$581,672,830

TABLE 8.—SUMMARY FOR MINERALS GROUPED ACCORDING TO CHARACTER OF ORES AND USES: 1902.

MINERALS BY GROUP.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	151,516	46,858	38,128	$39,020,552	581,728	$369,959,960	$20,677,938	$71,771,713	$123,814,967	$796,826,417
Metallic	4,280	4,081	8,138	9,948,335	110,404	84,046,224	1,371,921	17,168,321	39,639,703	215,453,587
Copper ore	144	144	1,208	1,768,456	26,007	21,151,405	188,768	1,397,465	11,083,175	51,176,036
Gold and silver	2,992	2,992	3,480	5,076,773	36,142	36,077,492	626,090	5,357,529	16,699,768	82,492,052
Iron ore	525	332	2,405	2,113,230	38,851	21,531,792	425,292	8,257,714	9,005,608	65,465,321
Lead and zinc ore	559	557	910	826,327	7,881	4,329,271	108,607	2,092,001	2,511,657	14,600,177
Manganese ore	19	19	18	9,395	194	74,924	....	3,845	17,228	177,911
Quicksilver	41	37	117	154,154	1,329	881,340	23,164	59,767	322,267	1,550,090
Fuels	140,463	36,017	22,383	22,216,322	372,559	236,377,041	19,066,167	47,805,691	61,928,469	469,297,671
Coal, anthracite	334	119	3,014	2,907,293	69,691	38,716,113	406,421	9,307,239	12,740,790	76,173,586
Coal, bituminous	5,652	4,409	14,413	14,511,924	280,638	181,483,288	1,244,114	16,774,469	24,798,922	290,858,483
Natural gas	15,806	1,967	1,923	1,810,337	4,678	2,935,279	4,459,001	5,912,257	6,607,255	30,867,863
Petroleum	118,671	29,522	3,033	2,986,768	17,552	13,242,361	12,956,631	15,811,726	17,781,512	71,397,739
Structural materials	6,014	5,746	6,342	5,699,130	86,295	44,654,537	60,749	5,750,482	20,072,399	96,370,559
Cement	101	93	913	1,087,514	13,041	6,328,852	10,627	1,665,520	9,098,226	24,867,338
Clay	205	203	185	150,505	2,433	958,892	13,241	126,878	272,823	2,061,072
Limestones and dolomites	3,246	3,137	2,231	1,848,747	31,547	14,750,638	36,381	1,440,081	5,408,912	30,441,901
Marble	83	75	352	341,021	4,070	2,212,640	....	382,877	825,922	5,044,192
Sandstones and quartzites	1,304	1,211	847	713,679	10,448	6,153,060	500	878,760	1,298,190	10,601,171
Siliceous crystalline rocks	906	853	1,377	1,227,885	18,836	11,072,996	....	810,206	2,493,065	18,257,944
Slate	139	174	437	334,879	5,920	3,177,459	....	446,145	680,361	5,096,951
Abrasive materials	82	75	75	48,008	610	296,914	....	42,410	80,309	1,177,711
Buhrstones and millstones	29	29	7	4,082	86	39,562	....	1,480	1,809	59,908
Corundum and emery	5	5	9	5,960	47	32,871	....	2,779	26,114	101,605
Crystalline quartz	6	5	8	6,030	29	13,502	....	1,950	950	43,085
Garnet	7	7	12	9,178	118	59,632	....	4,952	10,128	132,820
Grindstones and pulpstones	9	9	25	13,042	210	99,598	....	24,433	31,349	667,431
Infusorial earth, tripoli, and pumice	11	10	8	1,016	35	13,692	....	2,283	2,297	58,994
Oilstones, whetstones, and scythestones	15	10	6	5,100	85	37,977	....	4,533	7,662	113,868
Chemical materials	228	174	750	750,953	8,835	3,313,088	161,695	741,570	1,603,348	10,618,669
Borax	6	6	14	18,128	153	114,865	....	47,606	213,538	2,383,614
Fluorspar	22	18	42	27,312	262	110,002	300	23,602	31,374	275,682
Gypsum	62	45	249	300,420	1,472	759,258	406	200,769	341,760	2,089,341
Phosphate rock	115	87	391	355,201	5,971	1,930,093	157,402	430,475	799,414	4,922,943
Sulphur and pyrite	23	18	54	49,890	970	398,870	3,587	39,118	217,262	947,089
Pigments	84	77	91	68,752	592	236,372	1,000	60,448	65,845	564,039
Barytes	49	42	28	15,159	336	130,285	1,000	35,555	7,772	203,154
Mineral pigments, crude	35	35	63	53,593	256	106,087	....	24,893	58,073	360,885
Miscellaneous	335	698	349	289,052	2,443	1,035,784	16,406	202,801	424,994	3,344,181
Asbestos	4	4	7	2,628	23	8,250	....	1,758	8,233	46,200
Asphaltum and bituminous rock	24	24	52	48,233	156	79,570	10,000	19,753	21,928	236,725
Bauxite	38	7	42	33,230	150	59,763	500	14,939	40,019	128,206
Feldspar	27	28	27	20,085	252	107,444	....	19,407	50,278	250,424
Flint	12	17	18	14,330	119	47,454	....	14,291	18,642	144,209
Fuller's earth	4	4	14	10,000	114	33,775	4,021	2,057	28,966	98,144
Graphite	28	19	27	18,924	164	76,729	900	6,039	51,840	227,508
Lithium ore	3	3	1	600	6	3,744	....	200	1,265	25,750
Marl	11	11	2	2,100	13	4,769	....	1,407	2,755	12,741
Mica	19	38	21	13,444	98	44,043	....	12,914	11,961	118,849
Monazite	23	22	3	2,100	98	25,318	....	2,098	256	64,160
Precious stones	46	460	22	28,687	108	88,017	....	7,481	17,781	328,450
Silica sand	26	20	35	27,228	335	149,114	100	18,776	38,396	421,289
Talc and soapstone	20	20	75	63,713	771	279,083	....	80,136	125,932	1,138,167
Tungsten	4	4	....	....	2	1,260	....	120	210	5,975
Uranium and vanadium	3	3	2	3,500	19	17,040	....	490	3,010	48,125
All other minerals[1]	6	6	1	240	15	10,411	825	950	3,432	49,256

[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

As elsewhere explained, some of the substances included in the general groups by the Geological Survey are not covered by the census of mines and quarries. Further, the assignment of the different minerals to the respective groups should not always be accepted as an exact segregation. For instance, petroleum is assigned to the group of fuels, but a considerable proportion of the refined product is used for other purposes. In like manner, the group of "structural materials" includes all stone, although some sandstone is crushed and used in the pulverized form in the manufacture of glass, and a considerable amount of limestone is used for iron flux, for the manufacture of lime, and for roadmaking. There is, in fact, but slight connection between the totals for any of the groups other than their general relation to the industrial progress of the country. It is interesting, however, to note the proportion which each of these groups contributes to the general totals for all mines and quarries. These proportions are shown in Table 9.



Production of Bituminous Coal: 1902.

Production of Gold and Silver: 1902.

Production of Petroleum: 1902.

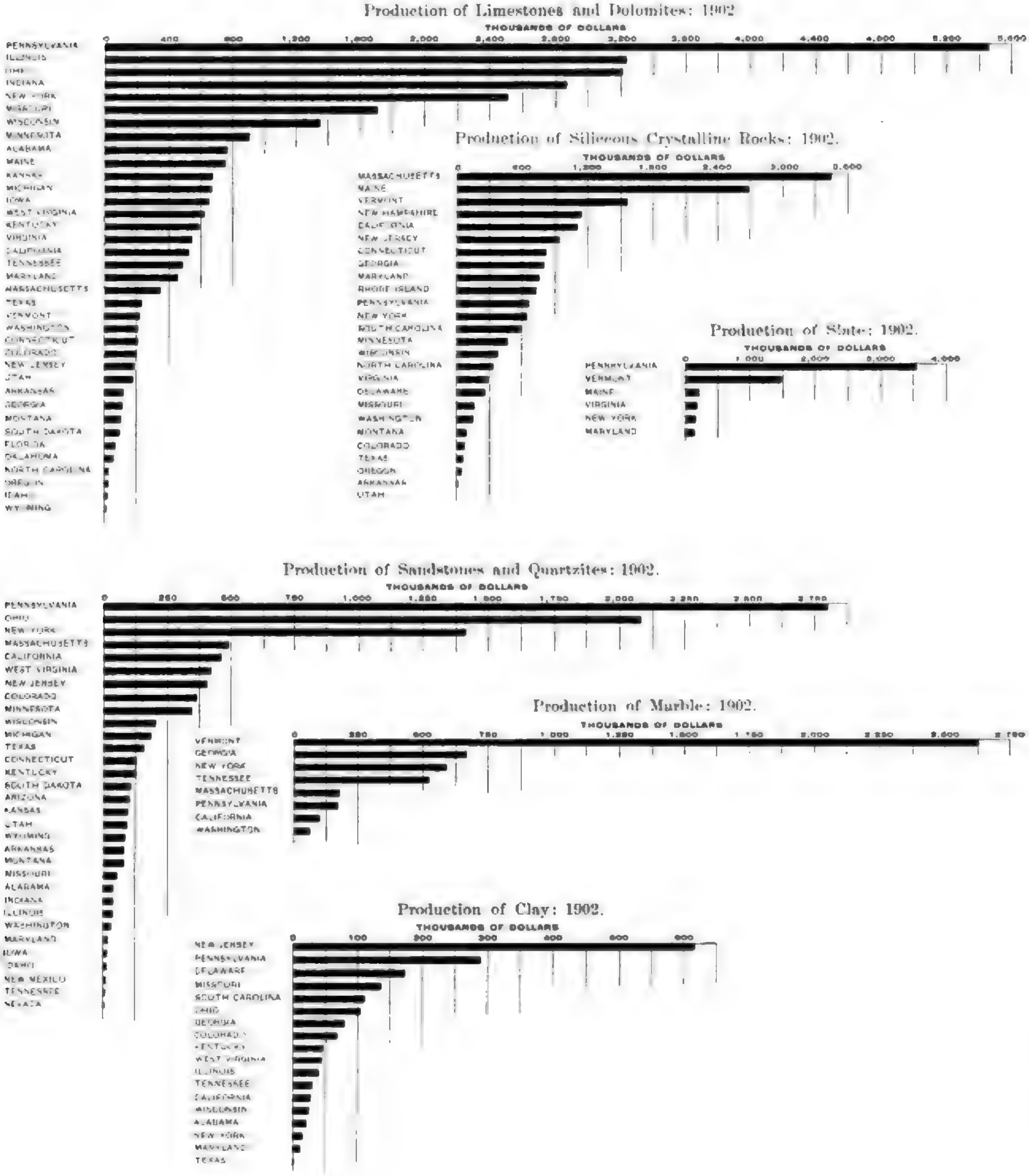
Production of Iron Ore: 1902.

Production of Copper Ore: 1902.

Production of Natural Gas: 1902.

Production of Cement: 1902.

DIAGRAM II.—PRODUCTION OF PRINCIPAL MINERALS, BY STATES AND TERRITORIES [illegible] Continued



Production of Limestones and Dolomites: 1902.

Production of Siliceous Crystalline Rocks: 1902.

Production of Slate: 1902.

Production of Sandstones and Quartzites: 1902.

Production of Marble: 1902.

Production of Clay: 1902.

TABLE 9.—PERCENTAGE EACH GROUP OF MINERALS FORMS OF TOTAL: 1902.

GROUP.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Metallic	2.8	8.7	21.4	25.5	19.0	22.7	6.6	23.9	32.0	27.0
Fuels	92.7	76.9	58.7	56.9	64.1	63.9	92.2	66.6	50.0	58.9
Structural materials	4.0	12.3	16.6	14.6	14.8	12.0	0.3	8.0	16.2	12.1
Abrasive materials	0.1	0.1	0.2	0.1	0.1	0.1	....	0.1	0.1	0.2
Chemical materials	0.1	0.4	2.0	1.9	1.5	0.9	0.8	1.0	1.3	1.3
Pigments	0.1	0.1	0.2	0.2	0.1	0.1	(1)	0.1	0.1	0.1
Miscellaneous	0.2	1.5	0.9	0.8	0.4	0.3	0.1	0.3	0.3	0.4

[1] Less than one-tenth of 1 per cent.

Fuels are by far the most important group of minerals. Their production gave employment to 64.1 per cent of the wage-earners, and the value of the products belonging to the group formed 58.9 per cent of the total value reported for all minerals. The production of coal alone gave employment to more than 100,000 wage-earners in excess of the number employed in the production of all other minerals combined; the wages paid by operators of coal mines exceeded those paid by all other operators by $70,436,842; and the value of the annual production of coal was within $62,762,279 of the value of all other minerals.

The metalliferous minerals rank next in importance. The value of the crude metallic products constituted 27 per cent of the total value of products, and their production gave employment to 19 per cent of the wage-earners. This group is composed of the various ores and metals enumerated under the term "metallic" in Table 9. Of these, iron ore is the most important from the standpoint of wage-earners, and gold and silver the most important measured by value of products. Of the 110,404 wage-earners reported for the group, 38,851, or 35.2 per cent, were employed in the production of iron ore, and they received $21,531,792, or 25.6 per cent of the total wages for the group. The value of the iron ore produced was reported at $65,465,321, or 30.4 per cent of the total for the group. The gold and silver was valued at the mine at $82,482,052, which is 38.3 per cent of the total for the group, exceeding the value of the iron ore by $17,016,731. But on the other hand the number of wage-earners engaged in the production of iron ore exceeded the number for precious metals by 2,709. The wages, however, for precious metals exceeded those paid for iron ore by $14,545,709.

Structural materials ranked third in importance. This group includes marble, granite, and other stones and embraces a great variety of products. The production of structural materials gave employment to 14.8 per cent of all wage-earners engaged in the mining industries, and the wages of these employees formed 12 per cent of the total wages. The value of structural materials quarried amounted to 12.1 per cent of the total value of the products of all mining operations.

While the other groups enumerated in Table 9—abrasive materials, chemical materials, pigments, and miscellaneous substances—are important from the standpoint of the variety of their products and the uses made of them, the wage-earners engaged in their production and the value of their products form a very small proportion of the totals for all minerals.

Mineral products by states.—The contribution of each mineral and group of minerals to the aggregate for the United States having been considered, it may be of interest to examine the contribution of each state to this aggregate, irrespective of the character of the minerals produced. Mineral production is necessarily concentrated in the states containing the most extensive and most favorably situated deposits. The deposits located conveniently for utilization of the products have been developed to the detriment of those in less favored sections. These conditions have stimulated the development of the mineral deposits in certain states, and it frequently occurs that practically the entire product of a state is represented by a single mineral. The totals for the different states are presented in Tables 10 and 11, and the proportions are graphically shown in the accompanying diagram. Table 10 shows the general totals for all minerals in each state and territory, while Table 11 presents the value of the mineral products in each state and territory in comparison with the population and the gross value of the products of agriculture and manufactures as reported at the Twelfth Census, and also the rank of the state and the per capita value for each class of products. In addition to the gross value of products this table shows the net value of the manufactured products; i. e., the gross value less the cost of materials purchased in a partially manufactured form.[1]

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[1] For method of computing net product, see Twelfth Census, Report on Manufactures, Part I, page cxxxix.

DIAGRAM III.—VALUE OF ALL MINERAL PRODUCTS, AND VALUE OF EACH GROUP: 1902.

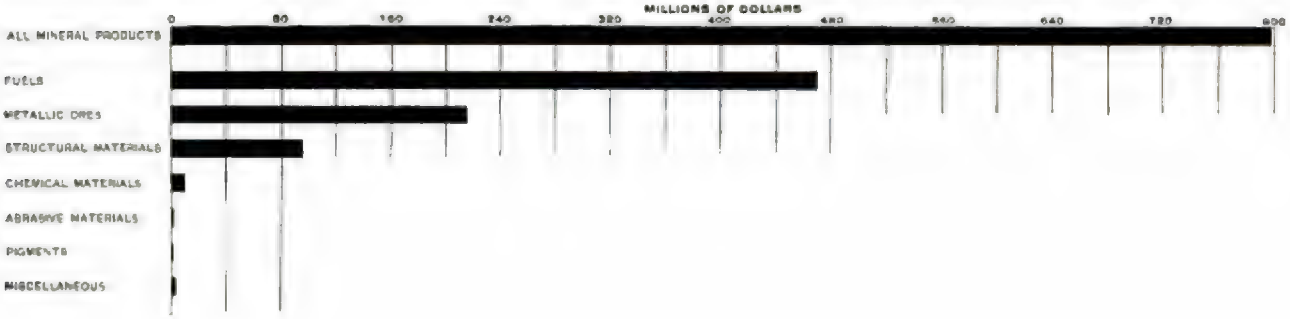

DIAGRAM IV.—PRODUCTION OF PRINCIPAL MINERALS: 1902

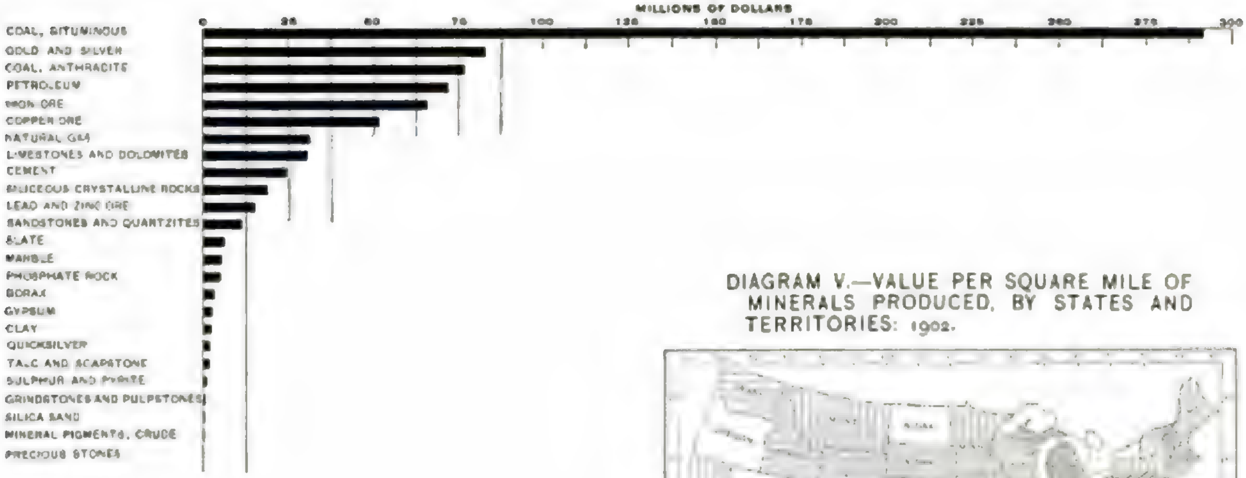

DIAGRAM V.—VALUE PER SQUARE MILE OF MINERALS PRODUCED, BY STATES AND TERRITORIES: 1902.

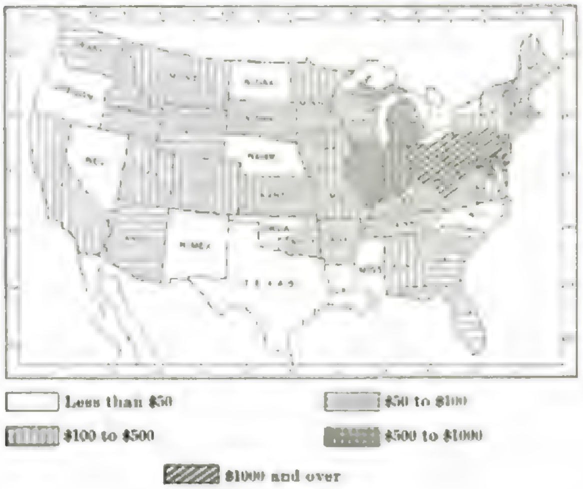

TABLE 10.—SUMMARY BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of mines, quarries and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
United States	151,516	46,858	38,128	$39,020,552	581,728	$369,959,960	$20,677,938	$71,771,733	$123,814,967	$796,826,417
Alabama	260	172	947	979,117	19,132	10,345,148	267,279	858,851	2,043,914	17,367,992
Arizona	113	158	445	710,183	5,323	5,069,065	159,942	392,495	3,060,521	11,197,375
Arkansas	120	131	210	191,528	2,944	1,945,479	860	95,481	244,379	2,840,341
California[1]	1,637	1,552	1,432	1,887,960	12,964	11,050,606	320,894	1,783,790	5,673,755	28,870,406
Colorado	1,147	1,011	1,896	2,663,333	20,519	18,874,836	393,985	3,032,544	7,006,846	40,693,296
Connecticut	90	78	151	132,065	1,497	808,772	....	50,918	226,075	1,425,959
Delaware	12	12	29	28,047	304	222,622	....	39,278	15,361	448,467
Florida	71	46	218	228,868	3,146	1,082,030	1,021	304,142	618,057	2,943,806
Georgia	149	127	308	209,261	2,820	1,065,047	122,619	231,145	566,067	3,117,858
Idaho	252	230	354	576,690	3,563	3,903,504	43,442	666,409	1,025,153	8,214,671
Illinois	1,116	1,023	1,869	1,910,940	40,523	26,986,397	26,016	1,543,903	3,515,853	38,234,410
Indian Territory	79	39	200	253,171	4,814	3,183,322	78,639	366,332	329,063	4,821,380
Indiana	16,825	3,909	1,662	1,139,578	16,473	10,729,767	2,164,390	3,887,668	3,810,666	28,224,760
Iowa	625	399	610	500,126	10,437	6,791,161	48,106	573,252	961,996	9,676,424
Kansas	1,259	398	565	727,242	8,726	5,680,598	213,182	767,009	1,374,883	10,700,285
Kentucky	1,142	665	854	666,900	10,654	5,193,792	224,923	610,613	1,207,771	8,533,423
Louisiana	8	3	8	7,533	61	34,444	105,858	25,820	7,354	279,327
Maine	135	141	208	183,814	3,684	2,284,789	....	121,556	176,964	3,656,134
Maryland	232	209	398	406,666	6,825	4,321,909	8,499	141,170	839,755	7,313,712
Massachusetts	251	234	360	399,978	4,242	2,525,405	1,833	273,791	762,335	4,071,855
Michigan	203	146	1,586	1,840,132	21,951	20,103,646	77,047	3,869,461	9,341,409	50,157,358
Minnesota	176	255	675	577,336	9,700	6,391,184	339,244	4,242,854	2,868,340	25,729,645
Missouri	1,045	973	1,488	1,273,811	15,351	8,757,967	172,614	2,118,436	2,850,018	20,284,656
Montana	281	271	571	912,177	10,580	11,812,150	64,636	893,256	3,107,102	28,265,185
Nebraska	36	35	12	8,001	178	95,976	....	2,790	11,178	148,391
Nevada	214	121	146	222,098	1,132	1,290,[illegible]	7,944	177,355	623,457	3,518,440
New Hampshire	76	62	92	68,971	1,258	806,491	....	56,993	141,128	1,176,712
New Jersey	162	151	420	367,000	5,645	2,658,727	10,770	303,669	2,235,961	6,605,642
New Mexico	161	207	175	309,569	2,275	1,646,893	48,381	140,065	197,919	2,686,473
New York	9,768	2,921	791	788,382	9,500	5,099,753	555,113	1,276,232	3,002,551	13,350,121
North Carolina	126	137	120	84,224	1,536	517,705	9,000	76,842	118,782	927,376
North Dakota	48	48	52	45,980	298	196,531	2,795	23,012	88,867	351,967
Ohio	11,864	11,358	2,430	2,551,087	57,173	33,222,680	2,701,557	7,711,026	10,126,452	57,186,922
Oklahoma	21	17	18	12,223	128	64,545	....	15,830	31,434	186,706
Oregon	294	293	153	189,165	1,166	1,083,075	19,522	143,718	408,112	2,087,389
Pennsylvania	48,672	12,266	9,368	9,562,910	280,935	144,122,437	5,598,074	23,218,856	38,111,903	296,871,417
Rhode Island	22	22	56	56,150	667	435,224	....	25,958	85,127	774,611
South Carolina	38	42	148	126,992	2,694	891,787	....	109,880	342,378	1,834,134
South Dakota	77	77	167	212,461	3,131	3,371,776	8,349	264,452	1,992,575	6,789,104
Tennessee	242	200	774	661,379	10,890	4,964,241	174,496	720,483	850,485	9,533,782
Texas	1,067	308	1,410	824,802	8,870	2,261,639	1,387,796	923,769	1,051,457	6,981,532
Utah	177	169	410	583,305	5,688	5,072,822	37,054	758,507	1,829,158	12,340,150
Vermont	192	160	433	376,077	5,598	3,111,599	....	392,734	1,076,113	5,904,706
Virginia	192	140	700	546,204	8,960	3,458,450	35,904	609,290	928,387	6,697,807
Washington	91	85	261	351,989	4,591	3,751,781	29,600	228,211	622,307	5,431,650
West Virginia	14,874	5,192	2,614	2,443,150	30,002	17,469,835	5,194,270	7,168,346	8,519,767	48,378,414
Wisconsin	411	392	275	252,758	3,583	1,987,565	3,778	427,847	804,142	4,427,813
Wyoming	71	50	153	188,616	4,406	3,432,050	15,547	290,662	818,496	5,681,256

[1] Includes 2 operators in Alaska and 1 in Hawaii.

TABLE 11.—RANK OF STATES AND TERRITORIES IN POPULATION, AGRICULTURE, MANUFACTURES, AND MINING.

STATE OR TERRITORY.	Population, 1900.	Rank.	Gross value of agricultural products, 1900.	Rank.	Gross value of manufactured products, 1900.	Rank.	Net value of manufactured products, 1900.	Rank.	Value of mining products, 1902.	Rank.	PER CAPITA (GROSS VALUE).		
											Agriculture.	Manufactures.	Mining.[1]
Alabama	1,828,697	18	$91,387,409	19	$80,741,449	30	$60,949,630	29	$17,367,992	12	$50	$44	$9
Arizona	122,931	48	6,997,097	47	21,315,189	41	19,294,712	41	11,197,375	15	57	173	86
Arkansas	1,311,564	25	79,649,490	22	45,197,731	38	28,810,655	37	2,840,341	35	61	34	2
California	1,482,179	21	131,690,606	14	302,874,761	12	175,425,385	13	28,844,669	7	89	204	19
Colorado	538,555	31	33,048,576	33	102,830,137	27	84,194,085	22	40,665,296	5	61	191	73
Connecticut	908,420	29	28,276,948	38	352,824,106	11	207,934,112	11	1,425,959	40	31	388	2
Delaware	184,735	46	9,290,777	46	45,387,630	37	29,378,529	36	448,467	44	50	246	2
District of Columbia	278,718	42	870,247	50	47,667,622	35	25,540,496	40	....	....	3	171	....
Florida	528,542	32	18,309,104	41	36,810,243	40	27,831,890	38	2,943,806	35	35	70	5
Georgia	2,216,331	11	104,304,476	17	106,654,527	26	78,153,556	24	3,117,858	34	47	48	1
Idaho	150,147	47	18,051,625	42	4,020,532	48	2,900,143	49	8,214,671	20	113	25	47
Illinois	4,821,550	3	345,649,611	2	1,259,730,168	3	840,375,269	3	38,234,410	6	72	261	8
Indian Territory	392,060	38	27,672,002	39	3,892,181	49	3,067,274	47	4,821,380	31	....	....	10
Indiana	2,516,462	8	204,450,196	9	378,120,140	8	257,976,214	7	28,224,760	9	81	150	11
Iowa	2,231,853	10	365,411,528	1	164,617,877	17	120,179,720	16	9,676,424	17	164	74	4
Kansas	1,468,469	22	240,855,512	7	172,129,398	16	130,060,308	15	10,700,285	16	163	117	7
Kentucky	2,147,174	12	128,296,786	15	154,166,365	18	108,325,261	19	8,533,423	19	60	72	4
Louisiana	1,381,625	23	72,667,302	23	121,181,683	22	69,785,397	28	279,327	46	53	88	(2)
Maine	694,466	30	37,113,469	33	127,361,485	21	84,210,956	21	3,656,134	32	53	183	5
Maryland	1,188,044	26	43,823,419	29	242,552,990	14	139,656,198	14	7,313,712	21	37	204	6

[1] Based on estimates of population, Census Bulletin 7.

[2] Less than 50 cents.

TABLE 11.—RANK OF STATES AND TERRITORIES IN POPULATION, AGRICULTURE, MANUFACTURES, AND MINING—Continued.

STATE OR TERRITORY.	Population, 1900.	Rank.	Gross value of agricultural products, 1900.	Rank.	Gross value of manufactured products, 1900.	Rank.	Net value of manufactured products, 1900.	Rank.	Value of mining products, 1902.	Rank.	PER CAPITA GROSS VALUE.		
											Agriculture.	Manufactures.	Mining.[1]
Massachusetts	2,805,346	7	42,298,274	32	1,035,198,989	4	657,277,001	4	4,671,866	29	15	369	2
Michigan	2,420,982	9	146,547,681	13	356,944,082	10	214,570,224	10	50,157,338	3	61	147	20
Minnesota	1,741,986	19	161,217,304	11	262,655,881	13	190,314,135	12	25,729,545	10	93	151	14
Mississippi	1,551,270	20	102,492,283	18	40,431,386	39	27,815,552	39	......	......	66	26	......
Missouri	3,106,665	5	219,296,970	6	385,492,784	7	256,671,841	8	20,284,658	11	71	124	6
Montana	231,529	44	28,616,957	37	57,075,824	34	30,180,514	32	28,275,085	8	124	247	106
Nebraska	1,066,300	27	162,696,386	10	143,990,102	19	115,278,644	18	148,394	48	153	135	(²)
Nevada	40,662	50	6,758,857	48	1,643,675	50	1,202,255	50	3,518,490	33	166	40	86
New Hampshire	411,588	35	21,929,988	40	118,709,308	24	77,390,702	26	1,170,312	41	53	288	3
New Jersey	1,883,669	16	43,657,529	30	611,748,933	6	355,646,950	6	6,045,402	25	23	325	3
New Mexico	195,310	45	10,155,215	45	5,605,795	46	4,122,500	46	2,086,473	37	52	29	13
New York	7,268,110	1	245,270,600	1	2,175,726,900	1	1,329,298,879	1	13,330,421	13	34	300	2
North Carolina	1,893,810	15	89,309,638	20	94,919,663	28	74,570,155	27	927,376	42	47	50	(²)
North Dakota	312,239	41	64,252,494	26	9,183,114	44	7,313,061	44	334,967	45	206	29	1
Ohio	4,157,545	4	257,065,826	3	832,438,113	5	523,249,207	5	57,188,922	2	62	200	13
Oklahoma	398,331	37	45,447,744	27	7,083,938	45	5,588,291	45	186,706	47	114	18	(²)
Oregon	409,704	36	38,090,969	32	46,000,587	36	30,383,627	35	2,067,389	38	93	112	5
Pennsylvania	6,302,115	2	207,895,600	8	1,834,790,860	2	1,104,871,690	2	226,871,417	1	33	291	36
Rhode Island	428,556	34	6,333,864	49	184,074,378	15	118,869,891	17	774,611	43	15	430	1
South Carolina	1,340,316	24	68,266,912	24	58,748,731	32	48,175,365	32	1,804,134	39	51	44	1
South Dakota	383,887	39	66,082,419	25	12,231,239	43	10,176,016	43	6,769,104	23	172	32	16
Tennessee	2,020,616	14	106,166,440	16	108,144,565	25	77,928,247	25	9,885,782	18	53	54	5
Texas	3,048,710	6	239,823,244	5	119,414,982	23	81,629,058	23	6,981,582	22	79	39	2
Utah	274,952	43	16,502,051	46	21,156,183	42	17,128,661	42	12,310,350	14	60	77	43
Vermont	343,641	40	33,570,892	35	57,623,815	33	40,760,890	34	5,304,305	26	98	168	14
Virginia	1,854,184	17	86,548,545	21	132,172,910	20	96,408,277	20	6,667,867	24	47	71	3
Washington	511,786	33	34,827,495	34	86,795,051	29	59,430,331	30	6,451,650	28	68	170	10
West Virginia	958,800	28	44,768,979	28	74,838,330	31	47,996,315	33	48,378,414	4	47	78	48
Wisconsin	2,062,916	13	157,445,713	12	360,818,942	9	243,068,466	9	4,427,813	30	76	175	2
Wyoming	90,570	49	11,907,415	44	4,301,240	47	2,974,163	48	5,083,290	27	131	47	58

[1] Based on estimates of population, Census Bulletin 7.

[2] Less than 50 cents.

While the mineral products of a state are dependent primarily on the extent and character of the deposits, their development is controlled by a number of factors, such as the proximity of the ore to the surface, nearness to markets, the extent and character of transportation facilities, the supply of labor and power, and the application of new and improved machinery and methods. The application of the steam shovel and other labor-saving devices in open cut iron mining, and of the cyanide process to the reduction of the precious metal bearing ores, are notable examples of the improvements in machinery and methods. Manufactures are largely dependent upon mineral products for fuel and raw material and their development must necessarily be preceded by a corresponding increase in mineral products. A similar, though not so intimate, interdependence exists between the products of agriculture and manufactures. The three industries are closely related, and, in the absence of far-reaching transportation facilities, there might be a certain harmony between the products of each in the different states, but the extensive, rapid, and easy means of transportation now available make it possible to utilize the minerals and agricultural products of one state in the manufactures of another, either adjoining or distant; there is, therefore, very little, if any, agreement in the relative rank of the different states in the three industries.

Accepting as comparable the statistics of population, agriculture, and manufactures for the Twelfth Census, which covered the fiscal year ending May 31, 1900, and the statistics for mineral industries, which covered the calendar year 1902, it appears that, as a rule, the value of the mineral products of the several states is far below the value of the products of agriculture and of manufactures, respectively. But in the states of Idaho, Nevada, and Wyoming and in Indian Territory the value of minerals exceeded the value of the products of manufactures; and they were in excess of the products of agriculture in the states of Colorado, Pennsylvania, and West Virginia and in Arizona and Indian Territory. Mineral products were reported for all of the states and territories with the exception of the District of Columbia and Mississippi. In many of the states, however, the value of the minerals reported was insignificant as compared with the value of the products of agriculture and manufactures. In several states—Delaware, Louisiana, Nebraska, North Carolina, North Dakota, and Rhode Island—and in the territory of Oklahoma they were less than $1,000,000, while the value of the products of agriculture and manufactures, respectively, in every state and territory exceeded $1,000,000, with the exception of the agricultural products reported for the District of Columbia. While there is not the same intimate relationship between population and mining that exists between population and agriculture and between population and manufactures, the per capita value of the mineral products has been included in Table 11 for the purpose of making a comparative showing.

Pennsylvania, which ranked second in population and manufactures, and eighth in agriculture, was the leading mining state in 1902, both in the number of wage-earners employed and in the value of products. Its high rank was due to the production of anthracite and bituminous coal, the wage-earners reported for the coal mines forming 84.7 per cent of the 190,935 reported for all mines in the state, and the products of such mines forming 76.9 per cent of the total product of $236,871,417. The position of Pennsylvania as the leading mining state was most pronounced. Out of a total of 581,728 wage-earners engaged in mining in the United States, Pennsylvania reported 190,935, or 32.8 per cent, who received as wages $114,122,437, or 30.8 per cent of the $369,959,960 reported as the total. The value of the state's production was equally high, being $236,871,417, or 29.7 per cent of the $796,826,417 reported for the United States. Practically one-third of the whole mining industry of the United States, as measured by the persons employed and the value of products, was confined to this state. While it is true that the exploitation of its enormous coal deposits has been responsible for Pennsylvania's position as the leading mining state and that this industry has assumed overshadowing proportions, it is also true that the state has produced a large variety of minerals. Of the 52 classes of minerals reported 23 were found in Pennsylvania, the state being exceeded in this respect only by California, with 26 classes, and by Virginia, with 24.

New York, which stood first in population and in manufactures and fourth in agriculture, was thirteenth in mineral products. The state's mineral industry, employed 1.6 per cent of the wage-earners, paid them 1.4 per cent of the wages, and produced 1.7 per cent of the total value of products. The 5 leading mining industries of New York were cement, limestones and dolomites, petroleum, sandstones and quartzites, and iron ore, ranking in the order named. For each of these classes a production of over $1,000,000 was reported, and the 5 together showed a production of $10,462,663, or 78.4 per cent of the total for the state.

Ohio, which ranked fourth in population, third in agriculture, and fifth in manufactures, held the second position in value of mining products. The total value reported for the state was $57,186,922. Of this amount the product of coal mines formed $26,953,789, or 47.1 per cent. The state also held third place in the number of wage-earners, the coal mining giving employment to 25,963, or 69.8 per cent of the 37,173 reported for the state. Next to coal, petroleum is Ohio's chief mining industry, the two combined contributing over four-fifths of the state's mineral wealth.

Michigan, ninth in population, tenth in manufactures, and thirteenth in agriculture, ranked third in mineral products. With 40.8 per cent of the total value of the iron ore output of the United States credited to it, Michigan was the leading producer of this mineral, which was the chief product of its mines. This industry claimed 14,456 wage-earners, or 45.2 per cent of the 31,951 employed in all the mines of the state, yielded them in wages $9,132,763, or 45.4 per cent of the total of $20,103,616; and the product itself was valued at $26,695,860, or 53.2 per cent of the $50,157,358 representing the total value of the output. After iron ore, Michigan's most important mineral product was copper ore, its output being valued at $18,247,207, a figure that was exceeded by Montana only. It will be noted that these two ores together were credited with a total value of $44,943,067, or 89.6 per cent of the total value of the mineral output of the state.

West Virginia, twenty-eighth in population and agriculture, and thirty-first in manufactures, was fourth in mineral products. The coal mines of the state gave employment to 23,914, or 79.7 per cent of the wage-earners, and their products formed $24,748,658, or 51.2 per cent of the total value of mineral products reported for the state. In the production of coal, West Virginia ranked fourth, being outranked only by Pennsylvania, Illinois, and Ohio, and the high ranking of these states as mineral producers was due, either wholly or in great part, to this industry. After coal, West Virginia's leading minerals were petroleum, with an output valued at $17,040,317, and natural gas, valued at $5,390,181. These three industries together account for 97.5 per cent of the reported mineral values of the state. It is interesting to contrast this condition with that of Michigan, the one producing, to an almost exclusive extent, fuels, and the other an enormous preponderance of ores.

Colorado, thirty-first in population, thirty-sixth in agriculture, and twenty-seventh in manufactures, ranked fifth in mineral products. This high position was due almost exclusively to the precious metals of the state. The gold and silver produced in 1902 were valued at $29,655,974, forming 73 per cent of the total production of the state, and 36 per cent of the total value of these minerals in the United States, and thus exceeding California's production of gold and silver, valued at $15,473,091, by almost 91.7 per cent. This industry in Colorado gave employment to 11,200 wage-earners, or 54.6 per cent of the 20,519 engaged in mining in the state, and returned to them as wages $11,726,123, or 62.1 per cent of $18,874,836, the total amount paid in wages. Bituminous coal with a value of production amounting to $8,397,812 ranked second in Colorado's mining industries, and iron ore was third with a product valued at $1,084,424.

Illinois, third in population and in manufactures, and second in agriculture, was sixth in rank as a mining state. Here, also, bituminous coal was the leading mineral. Its production employed 36,617 wage-earners, or 90.4 per cent of the 40,523 wage-earners engaged in mining in the state, and paid them $24,876,201, or 92.2 per cent of the $26,986,397 paid in wages in the state; and the product itself was valued at $33,945,910, or 88.8 per cent of the $38,234,410 reported as the total

DIAGRAM VI.—VALUE OF MINERALS PRODUCED IN EACH STATE AND TERRITORY: 1902.

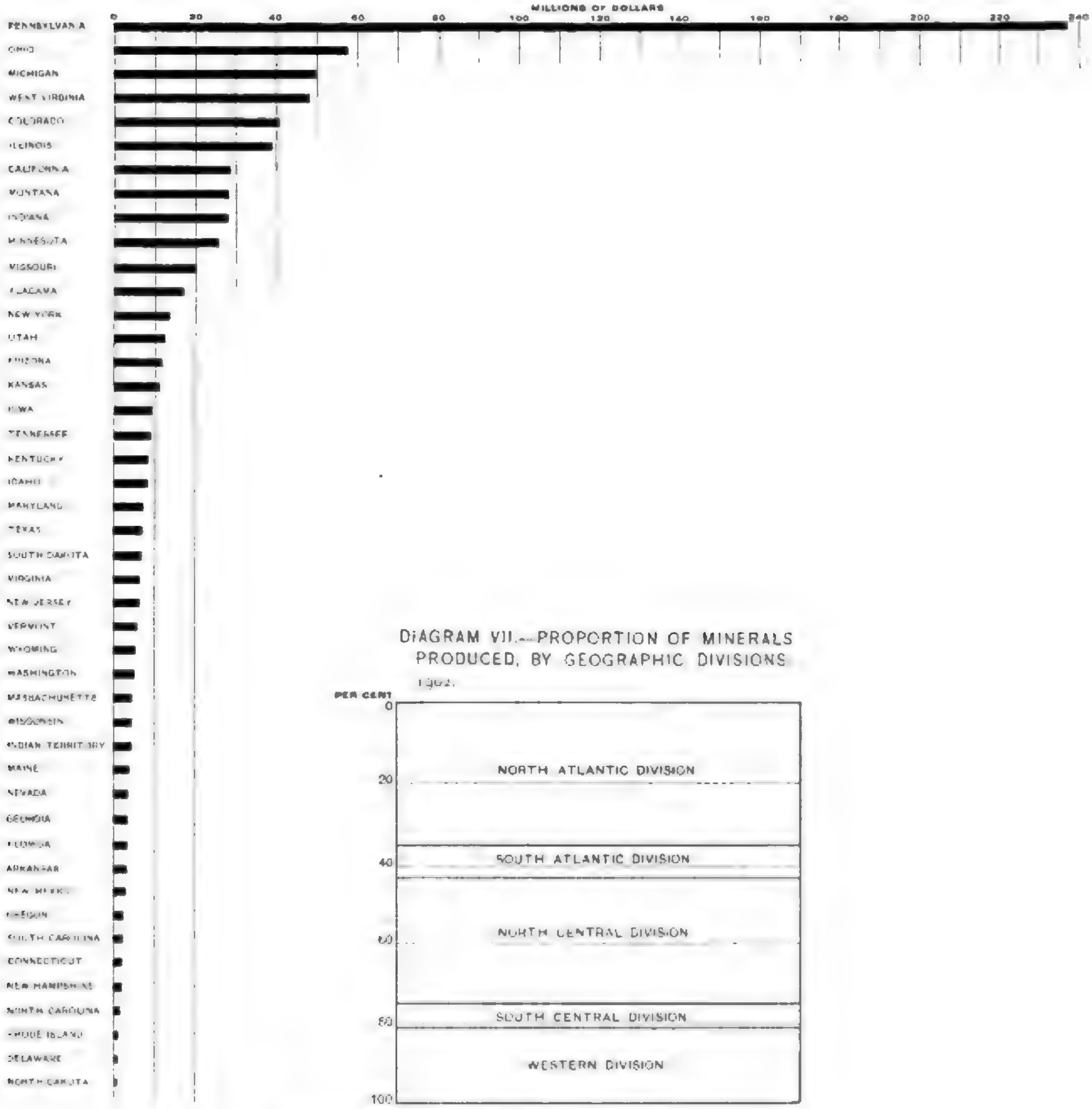

DIAGRAM VII.—PROPORTION OF MINERALS PRODUCED, BY GEOGRAPHIC DIVISIONS: 1902.

States with a production less than $300,000 not shown.

value of the state's mineral output. Limestones and dolomites, with a product valued at $3,232,123, constituted the industry second in importance.

California, twenty-first in population, fourteenth in agriculture, and twelfth in manufactures, ranked seventh in the value of mining products, but led the states in the variety of the minerals, reporting production in 26 of the 52 classes. It was unique also in the fact that at least two of its minerals, viz, chrome ore and magnesite, were mined nowhere else in the Union, and that in others, such as quicksilver and borax, its lead was so great that it may almost be said to have stood alone. The leading mineral products in California were gold and silver, valued at $15,473,091; petroleum, $4,873,617; borax, $2,370,994; copper ore, $1,599,663; quicksilver, $1,295,740; and siliceous crystalline rocks, $1,137,679. The state had 6 distinct mineral classifications, for each of which an output of over $1,000,000 was reported. Its leading mineral product, gold, although of less value than when it won for the state its title of "Golden," is still of greatest importance. In the mining of gold and silver there were employed 7,989 wage-earners, or 61.6 per cent of the state's 12,964 wage-earners engaged in mining; and these received as wages $7,101,003, or 64.3 per cent of the $11,050,666 paid as mining wages. Of the state's total output of all minerals, valued at $28,870,405, the precious metals contributed $15,473,091, or 53.6 per cent. California's production of gold and silver amounted to 18.8 per cent of the total value of the products of this industry in the United States, and was second only to that of Colorado. California produced 6.8 per cent of the country's value of petroleum; 99.5 per cent of borax; 3.1 per cent of copper ore; and 83.6 per cent of quicksilver.

Montana owes its rank as eighth among mining states almost entirely to its enormous production of copper ore, although the precious metals and bituminous coal, with outputs valued at $4,688,536 and $2,443,447, respectively, contributed about one-fourth of the value of the state's mineral products. The output of copper ore, valued at $20,563,353, or 40.2 per cent of the total for this industry, formed 72.8 per cent of the $28,265,085 reported as the total value of the state's mineral production, afforded employment to 6,388 wage-earners, or 60.6 per cent of the 10,539 mining wage-earners, and paid them $7,339,773, or 62.1 per cent of the total of $11,812,150 expended for wages. That Montana is preeminently a mining state is discernible at a glance when it is noted that in population, agriculture, and manufactures it ranked forty-third, thirty-seventh, and thirty-fourth, respectively.

Indiana, closely pressing Montana, ranked ninth in the products of mines and quarries, a position which is the result of the value of its fuel products, its leading mineral resources being bituminous coal, natural gas, and petroleum. Structural materials, as represented by limestones and dolomites and cement, also contributed much to the state's mineral wealth. The five classes of products just mentioned show a value amounting to $28,159,545, which is 99.8 per cent of the total for the state, $28,224,760. The total was distributed among the five as follows: Bituminous coal, $10,399,660, or 36.8 per cent; natural gas, $7,081,344, or 25.1 per cent; petroleum, $6,526,622, or 23.1 per cent; limestones and dolomites, $2,865,691, or 10.2 per cent; and cement, $1,286,228, or 4.6 per cent. Of the 16,473 wage-earners engaged in mining in Indiana, 10,593, or 64.3 per cent, were employed in extracting coal, receiving in wages $7,396,425, which is 68.9 per cent of the $10,729,767 paid in mining wages in the state. The state ranked ninth in agriculture, while in population and manufactures it was eighth.

Minnesota, nineteenth in population, eleventh in agriculture, and thirteenth in manufactures, was tenth in mining. The total value of its mining production was $25,729,545, of which $23,989,227, or 93.2 per cent, was credited to iron ore. There were but 6 of the different classes of minerals reported for the state, and none except iron ore had an output valued at more than $1,000,000. Of the 9,760 wage-earners employed in the state's mines, 8,256, or 84.6 per cent, were credited to the iron ore industry, receiving 84.1 per cent, or $5,376,933 of the $6,391,184 paid out as the total wages. In this industry Minnesota was exceeded by Michigan only, contributing 36.6 per cent of the total value as compared with Michigan's 40.8 per cent.

Mineral products by geographic divisions.—The mining statistics according to states and character and uses of minerals show the great preponderance of certain states and of a few ores in the forming of the totals for the country. The concentration of all, or any one, of the three productive industries—agriculture, manufactures, and mining—in any particular locality is indicative of the predominating industrial characteristics of that locality. The physical and industrial features of groups of neighboring states are in many cases so similar that a distinct advantage in clearness of presentation is realized by combining such states and treating the groups as geographic units. Such a geographic summarization brings together groups of neighboring states, each group embracing from 8 to 12 states and territories, in which the prevailing industrial conditions and the mineral and other natural resources are in many respects similar. This is especially true in the mining industries. The five geographic groups—North Atlantic, South Atlantic, North Central, South Central, and Western—are deemed sufficient to illustrate this similarity. Table 12 shows the value of the products of manufactures, agriculture, and mining for each of the geographic subdivisions and the rank of each in each industry, and also the population of each group, with its rank in population.

TABLE 12.—POPULATION, VALUE OF AGRICULTURAL PRODUCTS, MANUFACTURES (GROSS AND NET), AND MINERAL PRODUCTS, WITH RANK OF EACH, BY GEOGRAPHIC DIVISIONS.

DIVISION.	POPULATION, 1900.		AGRICULTURAL PRODUCTS, 1900.		MANUFACTURES, 1900.				MINERAL PRODUCTS, 1902.	
	Number.	Rank.	Value.	Rank.	Gross value.		Net value.		Value.	Rank.
					Amount.	Rank.	Amount.	Rank.		
Total	75,994,575	......	$4,717,069,973	......	$13,010,036,514	......	$8,367,997,844	......	[1]$796,901,681	
North Atlantic	21,046,695	2	666,347,364	3	6,438,658,774	1	3,972,170,421	1	274,499,816	1
South Atlantic	10,443,480	4	455,132,097	4	858,752,646	3	567,175,801	3	71,731,024	4
North Central	26,333,004	1	2,380,011,670	1	4,338,451,840	2	2,918,725,021	2	251,874,666	2
South Central	14,080,047	3	888,752,690	2	680,254,290	4	466,597,145	4	50,044,183	5
Western	4,091,349	5	336,646,345	5	655,628,974	5	444,221,456	5	148,873,675	3

[1] Exclusive of Alaskan coal and Hawaiian stone products.

The table enables the reader to grasp at a glance the leading industries of the different sections of the country. It should be borne in mind, however, that this treatment does not take into consideration the production of the fisheries, which in some sections assumes proportions of considerable magnitude.

The leading group in the mineral industries is the North Atlantic, with a value of products amounting to 34.4 per cent of the total. This group is followed, in order, by the North Central, with 31.6 per cent of the total; the Western, with 18.7 per cent; the South Atlantic, with 9 per cent; and the South Central, with 6.3 per cent.

The North Atlantic division owes its ranking position primarily to the enormous coal production of Pennsylvania. Illinois and Ohio, with their output of coal, and Minnesota and Michigan, with their iron and copper ores, explain the second rank held by the North Central division. The Western group ranks third chiefly because of Colorado's gold and silver and bituminous coal, and because of California's production of the precious metals, petroleum, borax, etc.

II.

DEVELOPMENT WORK.

For census purposes all mines, quarries, and petroleum and natural-gas wells were classed as either "productive" or "unproductive," the latter being regarded as engaged in development work. Development work is an incident in the operation of all mines and quarries, but there were 4,126 properties reported in which the work during 1902 was entirely of this class. The labor employed in this development work and the expenses incident to it form a part of the mining operations of the country, and should be included in the statistics; but, in order to preserve harmony among the items—number of employees, wages, expenses, and quantity and value of product—the productive and unproductive classes have been treated separately. In making this separation it was necessary to classify as "development work" all mines for which labor, but no product, was reported; and it is probable that some of them were not engaged in development work at all, but were idle, the employees being engaged simply in preserving and caring for the property. It is difficult to trace the line of demarcation between development work and other mining operations. A large proportion of the employees of a mining company may be engaged in sinking new shafts or making new tunnels to reach undeveloped deposits, and yet if even a small production is reported the mine is necessarily classed as a producing property; but, on the other hand, the sinking of new shafts may be only incidental to the working of new deposits from which valuable products are obtained. The employees engaged in surveying, drilling wells, clearing ground, building flumes, making shafts or tunnels, and, in fact, in doing any work except the actual digging and delivery of the ore, may, on a strict interpretation, be classed as doing development work. Undoubtedly a great deal of development and exploiting work was done during the year on properties that were idle and apparently abandoned at the time they were visited by the census agent. It was impracticable to obtain any information concerning the work on such mines, and therefore the statistics for development work can not be accepted as covering the entire field. A general summary of the statistics for the mines, quarries, and wells classed as "productive" and "unproductive" is given in Table 13.

TABLE 13.—PRODUCTIVE AND UNPRODUCTIVE MINES, QUARRIES, AND WELLS: 1902.

MINERAL.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.
			Number	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.		
Total	155,642	50,508	40,812	$41,714,454	595,366	$392,761,895	$23,342,464	28,202	$73,094,030	$129,968,111
Productive	151,516	46,858	38,128	39,020,552	581,728	379,959,960	20,677,938	21,183	71,771,713	123,811,967
Unproductive	4,126	3,650	2,684	2,693,902	13,638	12,801,935	2,664,526	7,019	1,322,317	6,156,144
Coal, anthracite and bituminous:										
Total	6,017	4,550	17,476	17,462,659	350,754	229,469,766	1,684,302	6,906	26,104,518	37,710,122
Productive	5,986	4,528	17,427	17,419,217	350,329	229,198,401	1,650,535	6,771	26,081,698	37,539,702
Unproductive	31	22	49	43,442	425	271,365	33,767	135	22,820	170,420
Gold and silver:										
Total	6,214	6,244	5,764	7,412,243	47,905	47,658,176	2,168,861	6,629	6,374,885	21,774,845
Productive	2,962	2,992	3,480	5,076,773	36,142	36,077,492	626,090	980	5,357,529	16,699,768
Unproductive	3,252	3,252	2,284	2,335,470	11,763	11,580,684	1,542,771	5,649	1,017,356	5,075,077
Petroleum:										
Total	119,786	29,728	3,182	3,108,518	17,723	13,401,539	13,715,064	8,702	15,929,740	18,285,193
Productive	119,171	29,522	3,033	2,986,768	17,552	13,212,361	12,956,631	7,949	15,811,726	17,781,512
Unproductive	615	206	149	121,750	171	189,178	758,433	753	118,014	503,681
Iron ore:										
Total	592	365	2,133	2,134,945	39,118	21,688,394	641,460	1,365	8,326,247	9,149,149
Productive	555	332	2,105	2,113,230	38,851	21,531,792	425,292	1,079	8,257,714	9,005,608
Unproductive	37	33	28	21,715	267	156,602	216,168	286	68,533	143,541
Copper ore:										
Total	159	159	1,263	1,832,364	26,309	21,335,826	188,968	196	1,435,965	11,219,022
Productive	144	144	1,208	1,768,156	26,007	21,151,405	188,768	195	1,397,465	11,083,175
Unproductive	15	15	55	64,208	302	184,421	200	1	38,500	135,847
Natural gas:										
Total	15,400	2,008	1,938	1,817,782	4,715	2,990,383	4,763,231	3,441	5,922,166	6,680,452
Productive	15,306	1,967	1,923	1,810,637	4,678	2,969,279	4,659,001	3,268	5,912,257	6,607,255
Unproductive	94	41	15	7,145	37	21,104	104,230	173	9,909	73,197
Limestones and dolomites:										
Total	3,249	3,140	2,235	1,846,547	31,580	14,761,068	36,381	137	1,441,156	5,409,162
Productive	3,246	3,137	2,231	1,843,747	31,547	14,750,638	36,381	137	1,440,081	5,403,912
Unproductive	3	3	4	2,800	33	10,430			1,075	5,250
Cement:										
Total	104	96	951	1,137,117	13,381	6,543,469	10,627	34	1,699,421	9,101,190
Productive	101	93	913	1,087,514	13,041	6,328,852	10,627	34	1,665,520	9,098,226
Unproductive	3	3	38	49,603	340	214,617			33,901	2,964
Siliceous crystalline rocks:										
Total	910	857	1,381	1,231,485	18,919	11,117,636			810,656	2,494,765
Productive	906	853	1,377	1,227,885	18,836	11,072,996			810,206	2,493,065
Unproductive	4	4	4	3,600	83	44,640			450	1,700
Lead and zinc ore:										
Total	584	582	934	842,086	7,952	4,372,958	116,795	240	2,093,446	2,529,827
Productive	559	557	910	826,327	7,881	4,329,271	108,646	223	2,092,001	2,511,657
Unproductive	25	25	24	15,759	71	43,687	8,149	17	1,445	18,170
All other minerals:										
Total	2,627	2,779	3,255	2,889,408	37,010	18,422,667	216,814	552	2,956,000	5,624,584
Productive	2,580	2,743	3,221	2,860,298	36,864	18,340,473	216,006	547	2,945,516	5,601,087
Unproductive	47	36	34	29,110	146	82,194	808	5	10,484	23,497

The 4,126 mines and quarries classed as unproductive were controlled by 3,650 operators. There were, on the average, 13,638 wage-earners employed by these operators during the year, and the total annual wages amounted to $12,801,935. The development work done on contract during the year amounted to $2,664,526; and, in addition, $2,693,902 was paid as salaries, and $7,475,461 was spent for miscellaneous expenses, supplies, and materials, making a total of $25,635,824 expended in development work, for which there was absolutely no return in production. Of this total, $21,551,358, or 84.1 per cent, was reported for the precious metals, the amount being expended by 3,252 operators. The remainder, $4,084,466, or 15.9 per cent, was expended by 398 operators engaged in exploiting and development work for a variety of minerals. Table 14 presents the statistics for development work in each state and territory.

TABLE 14.—DEVELOPMENT WORK, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.						CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.
					Total.		Above ground.		Below ground.					
			Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.		
United States	4,125	3,650	2,684	$2,698,902	13,658	$12,801,955	4,384	$3,768,387	9,274	$9,033,568	$2,664,525	7,019	$1,322,317	$6,150,144
Alabama	5	5	10	9,010	45	15,244	36	11,332	9	3,912			889	1,048
Arizona	381	381	396	459,452	2,246	2,329,945	607	640,801	1,639	1,689,144	197,324	317	124,849	924,313
Arkansas	6	3	1	900	1	350	1	350			4,500	5		50
California	492	460	319	320,189	1,575	1,425,819	530	473,895	1,045	952,924	180,586	265	171,632	826,664
Colorado	955	954	456	437,798	2,337	2,340,058	494	531,594	1,843	1,808,464	582,918	911	213,816	1,030,605
Florida	5	3	5	4,700	15	4,732	15	4,732			2,724	4	125	13,033
Georgia	9	9	7	8,808	40	15,817	10	3,863	30	11,954	210	1	485	7,297
Idaho	325	325	180	164,500	852	897,412	227	216,635	625	680,777	158,292	254	98,217	605,058
Illinois	3	3			5	2,125	5	2,125					25	2,900
Indian Territory	13	7	14	21,055	80	50,515	40	26,472	40	24,043	10,200	21	18,407	66,994
Indiana	79	12	8	2,920	1	269	1	269			21,979	47	6,417	9,118
Iowa	4	3	2	610	2	1,183	1	400	1	783	600	4	251	1,100
Kansas	108	18	16	5,892	19	16,463	9	10,295	10	6,168	97,511	78	10,956	90,685
Kentucky	243	58	40	23,481	33	25,693	33	25,693			185,733	209	22,857	67,620
Louisiana	12	9	4	1,170	9	8,610	9	8,610			65,375	37	1,489	15,800
Michigan	17	17	60	69,967	353	222,215	222	132,643	131	89,572			103,887	201,696
Minnesota	19	15	6	2,236	117	73,700	112	70,295	5	3,405	215,868	284	2,346	66,810
Missouri	32	27	29	10,220	67	43,213	27	18,551	40	24,662	12,149	26	3,225	22,852
Montana	129	128	77	83,099	520	592,626	98	110,840	422	481,786	65,737	810	37,397	275,796
Nevada	82	82	142	181,172	574	656,169	122	155,869	452	500,300	27,138	590	70,435	454,077
New Jersey	3	3	35	39,713	336	210,819	330	208,119	6	2,700			25,418	
New Mexico	159	159	107	90,121	358	270,896	66	53,521	292	217,375	73,129	1,923	34,125	128,488
New York	7	6	11	16,569	96	50,403	89	47,179	7	3,224	500	4	6,131	2,164
North Carolina	20	20	42	33,006	344	102,431	132	38,743	212	63,688			11,147	54,352
Ohio	11	8	1	6,000	204	122,722	204	122,722			14,174	27		27,912
Oklahoma	17	3	1	100							3,750	14	270	300
Oregon	192	192	139	162,184	839	805,855	213	186,275	626	619,580	75,594	137	47,191	241,161
Pennsylvania	22	13	8	3,590	44	20,752	39	18,257	5	2,495	36,332	119	1,677	39,216
South Dakota	114	114	99	114,505	522	581,163	132	147,506	390	433,657			15,210	165,585
Tennessee	15	5			5	2,000	5	2,000			16,403	16	1,910	2,627
Texas	71	61	36	27,209	48	46,766	48	46,766			246,542	240	29,912	51,679
Utah	275	273	214	162,711	965	920,624	172	165,353	794	755,271	162,745	298	133,551	468,705
Virginia	5	5	8	4,535	51	17,964	19	7,168	32	10,796	158	1	9,752	26,205
Washington	151	151	122	112,537	520	557,313	129	127,857	391	429,456	75,684	198	40,110	296,353
West Virginia	29	13	14	7,731	51	26,645	41	20,980	10	5,665	45,315	76	6,908	73,137
Wisconsin	4	4	5	4,500	7	4,025	5	2,701	2	1,324			1,078	5,250
Wyoming	98	87	79	86,984	309	318,301	107	113,208	202	205,093	86,204	123	35,120	140,754
All other states[1]	5	5	7	1,635	47	20,098	34	14,718	13	5,380			2,927	4,820

[1] Includes operators distributed as follows: Connecticut, 1; Maryland, 2; New Hampshire, 1; South Carolina, 1.

III.

LIMITATIONS OF THE USE OF CENSUS STATISTICS OF MINING.

The uses that can properly be made of the census figures are discussed in the reports on the different minerals, and also in different sections of this summary and analysis. The limitations imposed are similar to those which appear in connection with the use of the statistics of manufactures discussed in detail in Part I of the report on manufactures of the Twelfth Census.

The statistics of mines, quarries, and petroleum and natural-gas wells can be accepted as indicating the growth and relative importance of the states, and of the different sections of the country in the production of the different minerals. When possible the figures have been presented in comparative tables which embrace data reported at previous censuses. The figures can be used to ascertain the quantity and the value of the different minerals produced, the average number of persons employed in their production, and the total amount paid in wages in the different states at different census periods. The general condition of the mining industries of the country and the extent to which the mineral deposits in the different states have been developed can likewise be determined. The limitations of the use of these statistics may be summarized as follows:

1. The figures show only the total production for a period of twelve months. They do not indicate the character or extent of the mineral deposits or the proportion of these deposits that remains to be mined, nor the possible or relative advantages to be derived from mining in different sections of the country.

2. The exact relation between cost of mining and value of products can not be determined from the statistics. The Census inquiry was designed to obtain a complete statement of the more important items which make up the cost of mining, but there still remain many items of expense of which it was impossible to obtain a record. For this and other reasons the Census figures throw no light whatever upon the profits of mining, or upon the relative shares of the product which go to capital and labor, respectively. The items of expense which are presented separately in the Census reports are summarized in the following statement:

Value of products		$796,826,417
Cost of supplies and materials	$123,814,967	
Salaries, wages, and contract work	429,658,450	
Miscellaneous expenses	71,771,713	
Total cost		625,245,130
Excess of value of products over total cost		171,581,287

Such a calculation would make it appear that the profit of mining was about $170,000,000, but such a conclusion is unwarranted and improper. The figures take no cognizance of the depreciation of the plant, of expenses incident to the sale of the product, or of interest on capital invested; they ignore the element of loss due to bad debts and the element of risk and speculation incident to marketing the products. The value of the product reported to the Census is the value at the mine or quarry. It was beyond the scope of this investigation to follow the product further. The Bureau of the Census made no inquiry concerning the capital, accounts current, or assets of the mine operators, and it was impossible to determine from the schedules received whether the business had been conducted at a profit or at a loss during the year covered by the report.

3. The average earnings of employees can not be determined from these statistics. The reasons why this is not possible are given on page 85, where the statistics for employees and wages are discussed.

4. The Census figures can not be used to determine the respective shares of capital and of labor in the results of mining operations. The amount of money reported as paid out during the year in the form of wages can be taken as the contribution which the mining operators returned to the wage-earning class from the results of operations carried on, but what relation this sum bears to the interest earned on the total capital invested or to the total profits of mining it is impossible to estimate. Such relations can be determined only by special investigations of typical mines in selected lines of production.

IV.

NUMBER OF MINES, QUARRIES, AND WELLS.

A consideration of primary importance in any census investigation is the selection and proper definition of a suitable unit of enumeration. Generally the unit chosen is one that is sanctioned by common experience, as the individual in the enumeration of the population, the farm in agriculture, the establishment in manufactures, and the mine in mines and mining.

As defined by the mining laws of the United States the word "mine" applies to a single mining claim or a single shaft or other opening, and the term has been used in this sense whenever such a claim was mined separately. In the case of many mining properties, however—particularly those that were at an advanced stage of development—it was found that the property had grown beyond the boundary of one claim and included contiguous claims that frequently were connected with the original claim by underground tunnels and workings, and were so closely associated with it in their operations that even the owner or lessee could not segregate the operations of the different claims. The Bureau of the Census has designated as a mine, any claim or group of contiguous claims operated as a single property. In certain cases, however—as in that of the larger coal companies operating in the anthracite region of Pennsylvania—it was found impracticable to secure separate reports for collieries in the same county, even when noncontiguous, and in such instances, the reports were frequently made on a single schedule. On the other hand, in case of a mine worked by several lessees, each of whom operated independently, separate reports were often made, but whenever possible a single report of the operations was secured from the lessor, or the reports of the several lessees were consolidated. The operation of mines by lessees is a condition frequently found in the mining of precious metals and in the zinc mining region of southwestern Missouri.

A single oil or gas well under individual management or a number of contiguous wells under the same management were considered, for census purposes, as a single mine, but each well was also enumerated and counted in the tables as a separate unit. In the production of some minerals, such as precious stones, placer gold from small placer deposits, and monazite, mining in many instances was not carried on continuously at the same locality, and it was impossible to ascertain the number of distinct mining operations. The term "operator" represents the individual, company, or corporation that controls the mine. The distinct mining operations under the control of the same operator and located in the same county were included in one report to the Bureau of the Census, or in separate reports, to suit the convenience of the operator, but if the distinct operations were situated in different counties a separate report was made for each county.

At the census of 1880 the term "establishment of industry" was used in compiling the statistics of the mining industry. In defining this term it was said that "the term 'establishment of industry,' as used in these tables, may be taken to mean a mining operation the accounts of which are separate, and the product of which is not mingled with that of any other before it is shipped, though at the same time it may consist of numerous distinct mine openings."[1] This definition is in general, consistent with that adopted in this report, but certain important exceptions have been noted.

In the fieldwork of the present investigation special agents were instructed as follows: "It is important that a separate return be made for each mine or quarry, and that the statistics of employees, wages, expenses, and supplies entered on the schedule pertain only to the mine or quarry reported. This rule should be observed in all branches of mining and quarrying except petroleum and natural-gas wells, where all the wells located in a certain group or conducted under one ownership should be reported upon the same schedule. However, if more than one mine or quarry in the same county is owned by the same company or firm, and it is impracticable to make a separate report for each, a combined report may be made which will include the operations of all. Mines or quarries, under the same ownership in different counties, must be reported on separate schedules. If a schedule includes the operations of more than one mine or quarry, a memorandum, giving the name and post office address of each mine or quarry included, should be attached to the schedule." Sometimes it was impossible to state the number of mines reporting; this was the case with precious stones which, as a rule, are not obtained from regularly operated mines but through occasional findings or through systematic search. In such cases there is no mine, and the number of operators only is shown. It was also impracticable to ascertain the number of separate mines for gold and silver, and copper, and the number given is the number of operators. This practice was also followed in lead and zinc.

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[1] Tenth Census, Vol. XV, Report on Mining Industries, page xxiv.

In order to comply with the requirements of the law the canvass covered all mines and quarries, both large and small, and therefore included not only the commercial mines but also those worked to supply a local demand, such as the limestone quarry operated by a farmer to secure material for his own consumption or to furnish lime for the use of the immediate neighborhood, and the small, irregularly worked, bituminous coal mines. This practice has resulted in the inclusion of the large, fully equipped mining plants and the small stone quarries worked at irregular intervals. The large and small mines are given equal weight in ascertaining the number of mines and the number of operators. It is evident, therefore, that the unit, "a mine," is ambiguous and does not always signify the same thing. A thorough enumeration of the small mines or quarries worked to supply a product for local consumption is not essential to a mining census. They are incidental to the canvass, and special effort should be made to enumerate them only when they are characteristic of a locality or mineral. For instance, the enumeration of the small lead miners of Missouri or of the small bituminous coal operators of Kentucky is important, but, as explained on page 18, it is impossible to enumerate all of the small placer gold miners and their omission makes no appreciable difference in the aggregates. This is especially true when the total production of the metal can be obtained from other and more reliable sources.

The increase in the number of mines reported at different censuses is not necessarily an indication of an increase in the mining industry as a whole. The small operators might be especially active during the year of the canvass, while a number of the large mines might be idle or working on part time. Under such conditions the reports would show a larger number of mines but fewer wage-earners, less wages, and a smaller product than would be the case if the conditions were reversed. This is illustrated by the statistics for coal mining. There were 12,552 coal mines reported at the Eleventh Census, with 294,415 wage-earners, and a product valued at $160,226,323. In 1902 the number of mines reported decreased to 5,986, while the number of wage-earners increased to 350,329 and the value of the product, to $367,032,069.

No figures at previous censuses are available for a satisfactory comparison of the number of mines for all minerals, but the following statement shows the number of producing mines reported for some of the most important minerals at the censuses of 1902 and 1889:

Number of producing mines for principal minerals: 1902 and 1889.

MINERAL	NUMBER OF MINES AND WELLS.	
	1902	1889
Coal, anthracite	334	414
Gold and silver	2,992	3,729
Iron ore	525	592
Natural gas	15,806	2,247
Petroleum	118,671	35,163
Quicksilver	31	11

The number of mines was not shown at the Eleventh Census for many of the most important minerals, such as copper, lead, zinc, and manganese, and it is impossible to determine the number of independent properties engaged at that time in the production of these minerals. The above statement indicates that there were more mines engaged in the production of iron, anthracite coal, and the precious metals in 1889 than there were in 1902, and this is probably true for iron and coal. Notwithstanding this apparent decrease in the number of mines, there has been a large increase in the amount and value of the products for all the minerals enumerated. When, as is frequently the case, more than one variety of mineral is obtained from the same mine, it is impossible to give the number of mines producing each variety, and then present totals, without some duplication. This duplication was avoided at the present census by classifying the reports according to the mineral of chief value and counting each mine as a single unit, irrespective of the number of distinct minerals obtained from it.

The mines reported for each classification have been arranged in three groups: (1) Active mines reporting production; (2) active mines reporting no production, the work being confined to development, exploitation, or care of the property; (3) mines that were idle during the entire year. The number of these different classes of mines reported for each classification of minerals is shown in Table 15.

TABLE 15.—NUMBER OF ACTIVE AND IDLE MINES BY CLASSIFICATION OF MINERALS: 1902.

MINERAL.	Total.	Active mines with production.	Active mines without production.	Idle mines.
Total	163,580	151,516	4,126	7,938
Asbestos	19	4	....	15
Asphaltum and bituminous rock	43	24	6	13
Barytes	55	49	....	6
Bauxite	29	28	....	1
Borax	13	6	1	6
Buhrstones and millstones	37	29	....	8
Cement	152	101	3	48
Chrome ore	2	1	....	1
Clay	268	205	2	61
Coal, anthracite	350	331	2	17
Coal, bituminous	6,090	5,652	29	409
Copper ore	222	144	15	63
Corundum and emery	13	5	1	7
Crystalline quartz	10	6	....	4
Feldspar	36	27	....	9
Flint	25	19	....	6
Fluorspar	25	22	2	1
Fuller's earth	6	4	....	2
Garnet	9	7	....	2
Gold and silver	10,201	2,992	3,252	3,957
Graphite	43	28	3	12
Grindstones and pulpstones	13	9	....	4
Gypsum	79	62	....	17
Infusorial earth, tripoli, and pumice	18	11	....	7
Iron ore	782	525	37	220
Lead and zinc ore	742	559	25	158
Limestones and dolomites	4,628	3,246	3	1,379
Lithium ore	4	3	....	1
Lithographic stone	1	....	1	....
Magnesite	8	1	....	7
Manganese ore	90	19	3	68
Marble	197	83	10	104
Marl	115	11	....	104
Mica	85	49	....	36
Mineral pigments, crude	48	35	....	13
Molybdenum	1	1	....	....
Monazite	24	23	....	1
Natural gas	15,951	15,806	94	51
Nickel and cobalt	2	2	....	....
Nitrate of soda	1	....	....	1
Oilstones, whetstones, and scythestones	17	15	....	2
Petroleum	119,598	118,671	615	312
Phosphate rock	136	115	2	19
Precious stones	49	46	....	3
Quicksilver	107	41	10	56
Rutile	1	1	....	....
Sandstones and quartzites	1,614	1,304	1	309
Silica sand	28	26	1	1
Siliceous crystalline rocks	1,230	906	4	320
Slate	269	199	3	67
Sulphur and pyrite	32	23	1	8
Talc and soapstone	33	20	....	13
Tin	3	....	....	3
Tungsten	5	1	....	4
Uranium and vanadium	5	3	....	2

There was no attempt to make a complete enumeration of the idle mines and quarries, and the number reported includes only those that were enumerated incidentally in the canvass of the active properties. Many idle mines are virtually abandoned, and an enumeration of them would have no significance. In addition to the 163,580 active and idle mines, quarries, and wells, reports were received from 5,511 unpatented mining claims on which only assessment work was done during the year. Of the 151,516 productive mines, quarries, and wells, 118,671, or 78.3 per cent, were petroleum wells, and only 4,280, or 2.8 per cent, were engaged in the production of ores. The remaining 28,565, or 18.9 per cent, produced fuels; structural, abrasive, and chemical materials; pigments; and miscellaneous substances.

V.

NUMBER OF OPERATORS.

The 151,516 producing mines were controlled by 46,858 operators. The term "operator," as used in this report, stands for the individual, firm, incorporated company, or association that operates the mine or combination of mines. The "operator" is a more definite unit of measurement than the "mine." It represents a distinct interest and conveys an idea of the number of separate properties. It can be applied with some degree of certainty to the employees, wages, and value of products to determine the magnitude of the individual holdings, and such a comparison is made, for the principal minerals, in the following table:

TABLE 16.—AVERAGE NUMBER OF WAGE-EARNERS, WAGES, AND VALUE OF PRODUCTS PER OPERATOR, FOR THE PRINCIPAL MINERALS: 1902.

MINERAL.	Number of operators.	WAGE-EARNERS.		WAGES.		VALUE OF PRODUCTS.	
		Average number.	Average per operator.	Total.	Average per operator.	Total.	Average per operator.
Total	46,858	581,728	12	$369,959,960	$7,895	$796,826,417	$17,005
Coal, anthracite	119	69,691	586	38,716,113	325,345	76,173,586	640,114
Coal, bituminous	4,409	281,638	64	181,482,288	41,162	290,858,483	65,969
Copper ore	144	26,007	181	21,151,406	146,885	51,178,026	355,403
Gold and silver ore	2,992	36,142	12	36,077,492	12,058	82,482,052	27,568
Iron ore	332	38,851	117	21,531,792	64,855	65,465,321	197,185
Lead and zinc ore	557	7,881	14	4,329,271	7,772	14,600,177	26,212
Marble	75	4,070	54	2,212,640	29,502	5,044,182	67,256
Natural gas	1,987	4,678	2	2,966,279	1,493	30,867,863	15,535
Petroleum	29,522	17,552	1	13,242,361	449	71,397,789	2,418
All other minerals	6,711	96,218	14	48,250,319	7,162	108,278,978	16,134

Considering all classes of minerals, each operator gave employment on the average to 12 wage-earners and paid $7,895 in wages during the year, the annual product being valued at $17,005. The production of anthracite coal shows the largest results per operator and the production of petroleum the smallest per operator. While from a statistical standpoint both petroleum and natural gas are properly classed as minerals, the methods of production and distribution differ so radically from those of all other minerals that the statistics are not comparable and should, as far as possible, be treated separately. Excluding petroleum and natural-gas wells, there were 17,039 mines and quarries, controlled by 15,369 operators. Each operator employed on the average 36 wage-earners, paid $23,019 in wages, and reported a product valued at $45,192. Next to anthracite coal, the largest establishment per operator is shown for copper ore. In this industry 181 wage-earners were employed on the average by each operator.

Large and small operators.—These averages per operator are a general indication of the magnitude of the individual establishments for the entire country, but the large number of small operators included in the total tends to reduce the size of the average establishment without an increase in the total production corresponding to the number of operators employed. For instance, the average operator in anthracite coal gave employment to 586 wage-earners, but returns have been received from one operator in this industry who gave employment to as many as 22,662 wage-earners on the average during the busiest month of the year and who paid more than $6,000,000 in wages for the year's operation, the product being valued at more than $10,700,000. A report was also received from the operator of a copper mine who gave employment to 4,700 wage-earners during the busiest month, paid more than $2,700,000 in wages, and had an annual product valued at more than $8,800,000, whereas the average number of wage-earners employed per operator for this mineral is only 181. In the production of iron ore a single operator reported the employment of 4,664 wage-earners for the busiest month and paid more than $2,600,000 in wages, the value of his annual product amounting to over $11,700,000.

The average operator in the production of precious metals gave employment to only 12 wage-earners during the year, but the operator most largely engaged in the production of these minerals gave employment to 2,029 wage-earners during the busiest month of the year, paid in annual wages over $2,203,851, and had a product valued at the mine at more than $4,300,000.

When petroleum and natural gas are left out of consideration, the largest operator was reported for bituminous coal. This establishment gave employment to 15,629 wage-earners on the average during the year, paid more than $8,800,000 in wages, and had a product amounting to over $13,000,000.

The following table groups the operators according to the values of their products, and thus indicates the proportions of the total product obtained by large and small operators. The reports for petroleum and natural-gas companies have been excluded from this table, and the value of the by-products, referred to on page 25, have been reassigned to the total for the mineral from which they were obtained. This arrangement enables the presentation of the total value of products for each operator.

TABLE 17.—NUMBER OF OPERATORS AND VALUE OF THEIR PRODUCTS, GROUPED BY MINERALS INTO CLASSES BASED ON VALUE OF PRODUCT: 1902.

[Values have been omitted wherever they disclosed the products of individual establishments. Statistics for natural gas and petroleum are not included in this table.]

MINERALS BY GROUPS.	TOTAL.		LESS THAN $500.		$500 BUT LESS THAN $1,000.		$1,000 BUT LESS THAN $10,000.		$10,000 BUT LESS THAN $50,000.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	15,369	$694,560,815	4,044	$741,229	1,450	$1,031,235	5,111	$19,658,152	2,768	$66,566,573
Metallic	4,081	215,405,012	917	194,436	506	360,702	1,514	5,512,112	657	15,757,004
Copper ore	144	51,178,036	21	4,015	9	6,523	44	155,552	25	578,766
Gold and silver	2,992	82,482,052	775	164,190	421	299,076	1,158	4,062,016	382	8,929,366
Iron ore	332	65,416,746	40	8,792	21	15,152	76	383,525	88	2,293,576
Lead and zinc ore	557	14,600,177	71	15,640	51	37,370	216	840,037	147	3,646,066
Manganese ore	19	177,911	8	1,381	3	....	5	26,180	2	41,475
Quicksilver	37	1,550,030	2	418	1	....	12	44,802	13	267,856
Coal	4,528	367,084,464	798	151,329	347	247,689	1,417	5,478,708	901	23,382,403
Anthracite	119	76,173,586	....	....	....	....	3	15,828	23	669,863
Bituminous	4,409	290,910,878	798	151,329	347	247,689	1,414	5,462,880	878	22,712,540
Structural materials	5,746	97,057,224	1,827	330,755	557	369,080	1,966	7,742,558	1,067	23,967,508
Cement	93	24,137,396	....	....	1	....	11	67,149	21	476,358
Clay	203	2,048,653	58	7,988	18	11,236	84	328,320	55	1,304,272
Limestones and dolomites	3,137	30,570,880	1,295	224,575	398	217,965	948	3,566,608	460	10,182,691
Marble	75	5,044,182	2	....	1	....	18	79,524	35	860,875
Sandstones and quartzites	1,211	11,141,751	385	....	137	100,802	481	1,741,567	164	3,496,032
Siliceous crystalline rocks	853	18,408,541	78	23,046	19	34,483	360	1,720,381	233	5,625,115
Slate	174	5,696,051	8	1,187	5	3,279	48	239,009	79	1,906,165
Abrasive materials	75	584,085	11	2,829	10	6,751	40	146,615	11	244,661
Chemical materials	174	10,638,669	12	3,185	7	5,528	44	135,866	65	1,649,033
Pigments	77	364,039	11	2,125	12	9,001	38	121,559	14	312,498
Miscellaneous	688	3,228,822	468	58,590	51	32,484	105	400,744	58	1,273,466

TABLE 17.—NUMBER OF OPERATORS AND VALUE OF THEIR PRODUCTS, GROUPED BY MINERALS INTO CLASSES BASED ON VALUE OF PRODUCT: 1902—Continued.

MINERALS BY GROUPS.	$50,000 BUT LESS THAN $100,000.		$100,000 BUT LESS THAN $250,000.		$250,000 BUT LESS THAN $500,000.		$500,000 AND OVER.		UNCLASSIFIED.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	835	$60,710,340	696	$111,663,263	258	$86,686,893	211	$343,819,735	[1] 16	[2] $3,683,395
Metallic	187	13,192,517	128	20,037,323	78	28,649,585	81	128,018,138	[1] 16	[2] 3,683,395
Copper ore	6	379,162	8	1,160,687	8	3,265,037	23	45,628,294		
Gold and silver	103	7,221,740	74	10,825,929	46	15,907,681	33	33,438,219		[2] 1,633,835
Iron ore	32	2,475,367	34	6,347,899	20	8,032,103	21	45,870,302		
Lead and zinc ore	41	2,733,888	8		3		4	3,081,323	[1] 16	[2] 2,049,560
Manganese ore			1							
Quicksilver	5	382,130	3	351,690	1					
Coal	400	29,500,143	428	68,351,841	124	41,421,995	113	195,550,353		
Anthracite	20	1,657,946	31	5,365,298	16	5,740,512	26	62,724,139		
Bituminous	380	27,842,197	397	62,986,546	108	35,681,483	87	132,826,214		
Structural materials	208	15,022,986	125	20,659,250	31	11,901,063	15	17,074,044		
Cement	12	904,039	25	4,110,269	11	3,620,127	12			
Clay	8	506,842								
Limestones and dolomites	83	6,002,942	33	5,964,745	9	3,174,962	2	1,206,312		
Marble	11	783,607	6	1,022,100	2	2,240,725				
Sandstones and quartzites	31	2,397,138	10	1,746,642	2	507,214	1			
Siliceous crystalline rocks	42	2,940,916	30	6,285,219	5	1,729,351				
Slate	21	1,437,172	11	1,530,275	2	578,664				
Abrasive materials	3	182,229								
Chemical materials	28	2,169,745	12	2,063,802	1	1,364,250	2	3,177,200		
Pigments	2	118,856								
Miscellaneous	7	321,064	3	830,981	1	350,000				

[1] Custom mills which treated "sludge."

[2] Includes for lead and zinc ore the production of 16 custom mills treating "sludge" and the production of numerous small mines reported by landowners, no operators being given; and for gold and silver the production from deep and placer mines reported without operators.

In order to avoid disclosing the affairs of individual operators, the value of products is omitted from a number of the groups shown in Table 17, and for the same reason the statistics are not shown for the separate classifications under "abrasive materials," "chemical materials," "pigments," and "miscellaneous."

The following table, based on Table 17, shows the proportion that the number of operators and the value of their products for the different classes of establishments are of the totals for the United States and for each group of minerals:

TABLE 18.—NUMBER OF OPERATORS, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

[Statistics for natural gas and petroleum are not included in this table.]

VALUE OF PRODUCT.	GROUPS OF MINERALS.															
	Total.				Metallic.				Coal.				Structural materials.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	15,389	100.0	$694,560,815	100.0	4,081	100.0	$215,105,052	100.0	4,528	100.0	$367,081,161	100.0	5,746	100.0	$97,097,224	100.0
Less than $500	4,044	26.3	731,229	0.1	917	22.5	191,435	0.1	798	17.6	151,329	(1)	1,827	31.8	330,735	0.3
$500 but less than $1,000	1,450	9.4	1,031,235	0.2	506	12.4	290,702	0.2	347	7.7	247,680	0.1	517	9.0	399,080	0.4
$1,000 but less than $10,000	5,111	33.2	19,656,152	2.8	1,511	37.0	5,512,112	2.6	1,417	31.3	5,478,708	1.5	1,956	34.0	7,742,558	8.0
$10,000 but less than $50,000	2,768	18.0	66,566,573	9.6	657	16.1	15,737,004	7.3	901	19.9	23,882,103	6.4	1,067	18.6	23,967,508	24.7
$50,000 but less than $100,000	835	5.4	60,710,340	8.7	187	4.6	13,192,517	6.1	400	8.8	29,500,143	8.0	208	3.6	15,022,986	15.5
$100,000 but less than $250,000	696	4.5	111,663,263	16.1	128	3.1	20,037,323	9.3	428	9.5	68,351,841	18.6	125	2.2	20,659,250	21.3
$250,000 but less than $500,000	258	1.6	86,686,893	12.5	78	1.9	28,649,585	13.3	124	2.7	41,421,995	12.1	31	0.5	11,901,063	12.2
$500,000 and over	211	1.4	343,819,735	49.5	81	2.0	128,018,138	59.5	113	2.5	195,550,353	53.3	15	0.3	17,074,044	17.6
Unclassified[2]	16	0.1	3,683,395	0.5	16	0.4	3,683,395	1.7								

[1] Less than one-tenth of 1 per cent.

[2] Includes the production of 16 custom mills treating "sludge," the production of numerous small mines reported by landowners, no operators being given, and the production of gold and silver ore from small mines for which no operators were reported.

TABLE 18.—NUMBER OF OPERATORS, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902—Continued.

VALUE OF PRODUCT.	GROUPS OF MINERALS.															
	Abrasive materials.				Chemical materials.				Pigments.				Miscellaneous.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	75	100.0	$583,085	100.0	174	100.0	$10,638,669	100.0	77	100.0	$564,039	100.0	688	100.0	$3,228,322	100.0
Less than $500	11	14.7	2,829	0.5	12	6.9	3,185	(1)	11	14.3	2,125	0.4	468	68.0	56,590	1.8
$500 but less than $1,000	10	13.3	6,751	1.2	7	4.0	5,528	0.1	12	15.6	9,001	1.6	51	7.4	32,484	1.0
$1,000 but less than $10,000	40	53.3	146,615	25.1	44	25.3	195,866	1.8	38	49.3	121,559	21.5	105	15.3	460,738	14.3
$10,000 but less than $50,000	11	14.7	244,661	42.0	65	37.4	1,639,033	15.4	14	18.2	312,498	55.4	53	7.7	1,273,466	39.4
$50,000 but less than $100,000	3	4.0	182,229	31.2	28	16.1	2,169,745	20.4	2	2.6	118,856	21.1	7	1.0	524,064	16.2
$100,000 but less than $250,000	......	......	......	......	12	6.9	2,083,862	19.6	......	......	......	......	3	0.4	531,984	16.5
$250,000 but less than $500,000	......	......	......	......	4	2.3	1,364,250	12.8	......	......	......	......	1	0.2	350,000	10.8
$500,000 and over	......	......	......	......	2	1.1	3,177,200	29.9	......	......	......	......	......	......	......	......
Unclassified[2]	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

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[1] Less than one-tenth of 1 per cent.

[2] Includes the production of 16 custom mills treating "sludge;" the production of numerous small mines reported by landowners, no operators being given; and the production of gold and silver ore from small mines for which no operators were reported.

The total for all minerals, exclusive of petroleum and natural gas, shows that 211 operators, or 1.4 per cent of the total number, reported products aggregating $343,819,735, or 49.5 per cent of the total for all mines. Each of these operators reported a product valued at $500,000 or over. On the other hand, 5,494 operators, or 35.7 per cent of the total number, reported a product valued at $1,772,464, or only three-tenths of 1 per cent of the total; each of these operators reported a product valued at less than $1,000. There were 4,764 operators who reported a product valued at $10,000 or more, the total amounting to $673,130,199. They constituted only 31 per cent of the total number of operators, but their products formed 96.9 per cent of the total value of products. In other words, less than one-third of the operators produced more than nine-tenths of the mining products of the country, exclusive of petroleum and natural gas. The concentration of production is more pronounced in some of the minerals than in others. For instance, of the total for metallic substances, 3.9 per cent of the operators produced 72.7 per cent of the product; in coal mining, 5.2 per cent of the operators produced 65.4 per cent of the product; in structural materials, 25.2 per cent of the operators produced 91.3 per cent of the product; in abrasive materials, 18.7 per cent of the operators produced 73.2 per cent of the product; and in the production of all other substances, 29.1 per cent of the operators produced 88.2 per cent of the product. The table shows for each group of minerals a marked decrease in the percentage of operators in the higher value groups, accompanied by a corresponding increase in the proportion which their products formed of the total for all producers.

It has been the practice at previous censuses to omit from the tabulation the reports for all establishments showing an annual product valued at less than $500. If this practice had been followed at the mining census of 1902, there would have been omitted from the total 5,345 operators, or 29.8 per cent of all operators, their product being valued at $916,214, or one-tenth of 1 per cent of the total value of all products. These figures are exclusive of the reported values of product for several small operators connected with the Standard Oil Company, whose products, which were less than $500 each in value, are included in the returns made by that company. The omission, therefore, of the small operators would have but slight effect upon the statistics of production and labor.

The conditions in the mining industry differ radically from those in manufactures. The omission of the establishments with a product of less than $500 is made in the statistics of manufactures so as to avoid the necessity of securing and tabulating returns for small shops in which no one is employed except the owner, who may also be engaged in doing odd jobs, and would thus be more properly classed as a mechanic than as an independent manufacturer. This explanation would not apply to the statistics for mines and quarries. Many mines are operated only a part of the year, and the limited production is due to the short time of operation rather than to the size of the mine or to the extent of the deposits.

As explained on page 20, 7 returns were received from the Standard Oil Company relating to the production of petroleum and 4 relating to the production of natural gas. These schedules covered the work of 28,925 oil operators and 19 gas operators. As only 1 combined report was made for a large number of the operators, it is impossible to segregate the production of the operators so as to assign them to the different groups according to their production. The statistics of natural gas and petroleum are presented in Tables 19 and 20, the Standard Oil Company being considered as a single producer of both natural gas and petroleum.

Table 19.—NUMBER OF OPERATORS, NATURAL GAS AND PETROLEUM, CLASSED BY VALUE OF PRODUCT: 1902.

MINERAL.	TOTAL.		LESS THAN $500.		$500 BUT LESS THAN $1,000.		$1,000 BUT LESS THAN $10,000.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	[1]2,547	$102,265,602	1,301	$174,985	218	$151,378	647	$2,468,915
Natural gas	[2]1,949	30,867,863	1,202	149,837	137	94,173	370	1,319,305
Petroleum	[3]598	71,397,739	99	25,148	81	57,205	277	1,149,610

MINERAL.	$10,000 BUT LESS THAN $50,000.		$50,000 BUT LESS THAN $100,000.		$100,000 BUT LESS THAN $250,000.		$250,000 BUT LESS THAN $500,000.		$500,000 AND OVER.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	257	$5,392,356	52	$3,642,553	41	$6,565,769	14	$4,597,932	17	$79,271,714
Natural gas	162	3,415,085	27	1,815,176	28	4,406,721	10	3,385,729	13	16,281,837
Petroleum	95	1,977,271	25	1,827,377	13	2,159,048	4	1,212,203	4	62,989,877

[1] Exclusive of 28,942 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[2] Exclusive of 18 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[3] Exclusive of 28,924 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.

Table 20.—NATURAL GAS AND PETROLEUM, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

VALUE OF PRODUCT.	TOTAL.				NATURAL GAS.				PETROLEUM.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	[1]2,547	100.0	$102,265,602	100.0	[2]1,949	100.0	$30,867,863	100.0	[3]598	100.0	$71,397,739	100.0
Less than $500	1,301	51.1	174,985	0.2	1,202	61.7	149,837	0.5	99	16.6	25,148	(4)
$500 but less than $1,000	218	8.6	151,378	0.1	137	7.0	94,173	0.3	81	13.5	57,205	0.1
$1,000 but less than $10,000	647	25.4	2,468,915	2.4	370	19.0	1,319,305	4.3	277	46.3	1,149,610	1.6
$10,000 but less than $50,000	257	10.1	5,392,356	5.3	162	8.3	3,415,085	11.0	95	15.9	1,977,271	2.8
$50,000 but less than $100,000	52	2.0	3,642,553	3.6	27	1.4	1,815,176	5.9	25	4.2	1,827,377	2.6
$100,000 but less than $250,000	41	1.6	6,565,769	6.4	28	1.4	4,406,721	14.3	13	2.2	2,159,048	3.0
$250,000 but less than $500,000	14	0.5	4,597,932	4.5	10	0.5	3,385,729	11.0	4	0.7	1,212,203	1.7
$500,000 and over	17	0.7	79,271,714	77.5	13	0.7	16,281,837	52.7	4	0.7	62,989,877	88.2

[1] Exclusive of 28,942 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[2] Exclusive of 18 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[3] Exclusive of 28,924 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[4] Less than one-tenth of 1 per cent.

According to the table on page 60 the production of the average operator in natural gas was valued at $15,693 and in petroleum at $2,418, but in making these calculations the individual operators covered by the reports of the Standard Oil Company were counted as separate units. Considering the report of the Standard Oil Company as that of a single operator, it appears that seven-tenths of 1 per cent of the operators produced 77.5 per cent of the total production of petroleum and natural gas, or 52.7 per cent of the natural gas and 88.2 per cent of the petroleum.

VI.

CHARACTER OF OWNERSHIP.

The operators of mines and quarries were reported to the Census either as (1) individuals; (2) firms and limited partnerships; (3) incorporated companies; and (4) "other forms," embracing cooperative associations, municipalities, penal institutions, etc. The following table shows the number of operators and value of product under each of these classes of ownership as reported for each mineral and group of minerals. In this and the succeeding tables presenting the value of product according to the character of ownership, the value of the by-products referred to on page 25 have been included as a product of the mine or quarry producing them, irrespective of their character. This is necessary in order to show the total production of each operator.

TABLE 21.—NUMBER OF OPERATORS AND VALUE OF PRODUCT, BY CHARACTER OF OWNERSHIP: 1902.

[Exclusive of petroleum.]

MINERALS, BY GROUPS.	TOTAL.		INDIVIDUAL.		FIRM AND LIMITED PARTNERSHIP.		INCORPORATED COMPANY.		OTHER FORM.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	17,318	$725,428,678	8,460	$44,462,756	3,718	$52,782,143	4,951	$626,132,335	189	$2,051,444
Metallic	4,081	215,153,587	1,143	10,162,100	1,314	12,160,165	1,579	192,297,393	45	533,929
Copper ore	144	51,178,056	19	594,377	23	156,579	100	50,421,857	2	5,243
Gold and silver	2,992	82,482,052	958	[1]5,524,139	923	8,398,221	1,079	68,327,754	32	231,938
Iron ore	332	65,465,821	83	1,319,862	33	361,489	214	63,303,407	2	477,563
Lead and zinc ore	557	11,600,177	61	[2]2,584,011	328	3,073,822	159	5,823,159	9	119,185
Manganese ore	19	177,911	8	17,487	5	140,072	6	20,352		
Quicksilver	37	1,550,090	9	122,224	7	26,982	21	1,400,884		
Fuels	6,477	397,899,932	3,013	17,324,523	1,137	23,512,637	2,246	356,399,452	81	663,320
Coal, anthracite	119	76,173,586	9	1,128,330	34	5,836,032	76	69,209,224		
Coal, bituminous	4,409	290,858,483	2,044	15,606,913	827	17,212,050	1,517	257,639,318	21	390,252
Natural gas	1,949	30,867,863	960	589,250	276	463,655	[3]653	29,550,890	60	264,068
Structural materials	5,746	96,370,569	3,638	15,869,648	1,166	15,734,093	879	64,206,623	63	564,195
Cement	93	24,268,358	4	56,610	6	124,981	83	24,086,717		
Clay	203	2,061,072	115	804,377	46	255,618	42	1,000,077		
Limestones and dolomites; marble	3,212	35,185,983	2,297	7,139,210	494	5,462,914	389	22,486,393	32	107,466
Sandstones and quartzites	1,211	10,611,171	759	3,296,809	324	2,433,401	119	4,739,143	9	141,728
Siliceous crystalline rocks	853	18,257,941	436	1,045,069	219	4,066,978	176	9,130,876	22	215,001
Slate	174	5,696,051	27	617,553	87	2,433,111	60	2,645,387		
Abrasive materials	75	1,177,711	39	158,884	17	128,435	19	890,392		
Buhrstones and millstones	29	59,808	23	42,922	6	16,886				
Corundum and emery; crystalline quartz; garnet; grindstones and pulpstones; oilstones, whetstones, and scythestones	36	1,061,909	13	110,412	7	91,704	16	859,793		
Infusorial earth, tripoli, and pumice	10	55,994	3	5,550	4	19,845	3	30,599		
Chemical materials	174	10,618,669	34	417,011	24	829,026	116	9,372,632		
Borax	6	2,383,614					6	2,383,614		
Fluorspar; sulphur and pyrite	36	1,222,771	3	72,872	5	95,445	28	1,054,454		
Gypsum	45	2,089,341	13	114,925	6	26,775	26	1,947,641		
Phosphate rock	87	4,922,943	18	229,214	13	706,806	56	3,986,923		
Pigments	77	564,039	24	37,864	25	154,524	28	371,651		
Barytes	42	203,154	16	25,448	20	102,699	6	75,007		
Mineral pigments, crude	35	360,885	8	12,416	5	51,825	22	296,644		
Miscellaneous	688	3,344,181	549	492,726	35	259,263	104	2,592,192		
Asbestos; asphaltum and bituminous rock	28	282,928	3	26,682	3	8,900	22	247,346		
Bauxite; fuller's earth	11	226,350	3	19,075			8	207,275		
Feldspar	26	250,424	15	76,614	3	14,650	8	159,160		
Flint	17	144,209	10	22,808	4	27,750	3	93,651		
Graphite; lithium ore; marl, monazite and precious stones	515	658,609	483	163,522	4	12,100	28	482,987		
Mica	38	118,849	18	20,290	11	49,394	9	49,165		
Silica sand	20	421,289	5	68,914	5	103,608	10	248,767		
Talc and soapstone	20	1,138,167	4	39,921	8	18,655	13	1,079,591		
Tungsten	4	5,975	4	5,975						
Uranium and vanadium	3	48,125	3	48,125						
All other minerals[4]	6	49,256	1	800	2	24,206	3	24,250		

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[1] Includes $1,653,835 estimated value of the product of a number of miners working irregularly from whom no reports were received.
[2] Includes $1,965,779, for which character of ownership was not reported.
[3] Standard Oil Company entered as 1 company.
[4] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

Of the 17,318 operators included in Table 21, 8,460, or 48.8 per cent, were individuals; 3,718, or 21.5 per cent, firms and limited partnerships; and 4,951, or 28.6 per cent, incorporated companies; while 189, or 1.1 per cent, were cooperative associations, municipalities, penal institutions, etc.

The number of operators and the value of the production of petroleum are omitted from the table, because the character of ownership was not given for 28,924 of the 29,522 operators reported for the industry. Of the 598 operators of petroleum wells for which the form of ownership was reported, 107 were individuals, 69 firms, 417 incorporated companies, and 5 were reported under various kinds embraced in "other forms." With few and unimportant exceptions, each of the different classes of minerals enumerated was produced by operators conducting business under all three of the principal forms of ownership; i. e., individual, firm, and incorporated company. Of the 189 operators included in the group of "other forms" of ownership, 78 represent mines, quarries, or wells operated by the United States, or by city, or town governments, or by penal, or eleemosynary institutions. The remaining 111 mines, quarries, or wells were controlled by cooperative associations, receivers, lessees, religious organizations, and other miscellaneous forms of ownership. Of the 6 operators included in the group of "all other minerals," 1 was an individual, 2 were firms, and 3 were incorporated companies.

The following table shows the proportion of the operators and value of products for each mineral and group of minerals produced by individuals, firms and limited partnerships, incorporated companies, and other forms of ownership, respectively:

TABLE 22.—PER CENT DISTRIBUTION, BY CHARACTER OF OWNERSHIP, OF NUMBER OF OPERATORS, AND VALUE OF PRODUCT, FOR EACH MINERAL AND GROUP OF MINERALS: 1902.

[Exclusive of petroleum.]

MINERALS, BY GROUPS.	INDIVIDUAL.		FIRM AND LIMITED PARTNERSHIP.		INCORPORATED COMPANY.		OTHER FORM.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	18.8	6.1	21.5	7.3	58.6	86.3	1.1	0.3
Metallic	28.4	4.7	31.8	5.6	38.7	89.3	1.1	0.4
Copper ore	13.2	1.2	16.0	0.3	69.4	98.5	1.4	(1)
Gold and silver	32.0	6.7	30.8	10.2	36.1	82.8	1.1	0.3
Iron ore	25.0	2.0	9.9	0.6	64.5	96.7	0.6	0.7
Lead and zinc ore	11.9	17.7	58.0	21.1	28.5	60.4	1.6	0.8
Manganese ore	42.1	9.8	26.3	78.7	31.6	11.5		
Quicksilver	24.3	7.9	18.9	1.7	56.8	90.4		
Fuels	46.8	4.3	17.6	5.9	34.4	89.6	1.2	0.2
Coal, anthracite	7.5	1.5	28.6	7.7	63.9	90.8		
Coal, bituminous	46.4	5.4	18.7	5.9	34.4	88.6	0.5	0.1
Natural gas	50.3	1.9	14.1	1.5	32.5	95.7	3.1	0.9
Structural materials	63.3	16.5	20.3	16.3	15.3	66.6	1.1	0.6
Cement	4.3	0.2	6.5	0.5	89.2	99.3		
Clay	56.7	69.0	17.7	12.5	25.6	18.5		
Limestones and dolomites, marble	71.5	20.1	15.4	15.4	12.1	63.9	1.0	0.6
Sandstones and quartzites	62.7	30.3	26.8	23.5	9.8	44.9	0.7	1.3
Siliceous crystalline rocks	51.1	22.1	25.7	27.2	20.6	49.5	2.6	1.2
Slate	15.5	10.8	50.0	42.7	34.5	46.5		
Abrasive materials	52.0	13.5	22.7	10.9	25.3	75.6		
Buhrstones and millstones	79.3	71.8	20.7	28.2				
Corundum and emery; crystalline quartz; garnet; grindstones and pulpstones; oilstones, whetstones, and scythestones	36.1	10.4	19.5	8.6	44.4	81.0		
Infusorial earth, tripoli, and pumice	30.0	9.9	40.0	35.4	30.0	54.7		
Chemical materials	19.5	3.9	13.8	7.8	66.7	88.3		
Borax					100.0	100.0		
Fluorspar; sulphur and pyrite	8.3	6.0	13.9	7.8	77.8	86.2		
Gypsum	28.9	5.5	13.3	1.3	57.8	93.2		
Phosphate rock	20.7	4.6	14.9	14.4	64.4	81.0		
Pigments	31.2	6.7	32.5	27.4	36.3	65.9		
Barytes	38.1	12.5	47.6	50.6	14.3	36.9		
Mineral pigments, crude	22.8	3.4	14.3	14.4	62.9	82.2		
Miscellaneous	79.8	14.7	5.1	7.8	15.1	77.5		
Asbestos; asphaltum and bituminous rock	10.7	9.4	10.7	3.2	78.6	87.4		
Bauxite; fuller's earth	26.7	8.4			73.3	91.6		
Feldspar	57.7	30.6	11.5	5.8	30.8	63.6		
Flint	58.8	15.8	23.5	19.3	17.7	64.9		
Graphite; lithium ore; marl; monazite; and precious stones	93.8	24.8	0.8	1.9	5.4	73.3		
Mica	47.4	17.1	28.9	41.5	23.7	41.4		
Silica sand	25.0	16.4	25.0	24.6	50.0	59.0		
Talc and soapstone	20.0	3.5	15.0	1.6	65.0	94.9		
Tungsten	100.0	100.0						
Uranium and vanadium	100.0	100.0						
All other minerals[2]	16.7	1.6	33.3	49.2	50.0	49.2		

[1] Less than one-tenth of 1 per cent.

[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Individual ownership.—This form of ownership follows the individual prospector and is peculiar to the development of small mines, large numbers of which were reported for bituminous coal, limestones and dolomites, and for other minerals well distributed and so located that they could be worked with a limited capital. Practically all of the operators in precious stones and the majority of those in natural-gas and petroleum wells were enumerated as individuals. Nearly half of all the mining operations reported were conducted by individuals, and this form of ownership existed in the production of practically all kinds of minerals; but the production itself was comparatively unimportant. This is indicated by the value of product, which amounted to $41,462,756 in the case of individuals, and formed only 6.1 per cent of the total for all mines. Comparatively few individual operators conducted enterprises of great magnitude, but in the production of 13 different classes of minerals, enumerated in Table 21, the product reported for individual operators exceeded that of firms or partnerships. In no case, however, did the value of the products of individuals exceed the value of the products of incorporated companies.

Firms or partnerships.—In many instances these forms of ownership are but a step to the formation of incorporated companies. They include all firms and partnerships, whether general or limited. The 3,718 firms or partnerships formed 21.5 per cent of the total number of operators, and their products were valued at $52,782,143, or 7.3 per cent of the total value of products. The number of firms or partnerships was not as great as the number of individuals, but the value of their products exceeded the value of the products of individuals by $8,319,387, or 18.7 per cent. The product under the firm or partnership form of ownership exceeded the product under incorporated companies in the cases of manganese ore, barytes, and mica. No firms or partnerships were reported as engaged in the production of borax, bauxite, fuller's earth, tungsten, or uranium and vanadium.

Incorporated companies. From the standpoint of value of products the incorporated form of ownership now predominates in both manufactures and mining, but especially in mining. According to the reports of the census of 1900 the value of the products of incorporated companies engaged in manufactures formed 59.5 per cent of the total gross value of products of all manufactures. In the mining industry the products of the incorporated companies formed 86.3 per cent of the total for all mines and quarries. This form of ownership includes all joint stock companies, the capitalization of which is usually divided into shares of a fixed authorized value, transferable at the option of the individual shareholders. These companies are usually incorporated under the general corporation laws of the different states, but in a number of instances the charters are obtained by a special act of the legislature. The predominating importance of the corporation in the production of the different classes of minerals is shown by Table 22. This form of ownership was reported for all of the minerals, with the exception of buhrstones and millstones, lithium ore, tungsten, and uranium and vanadium, and in all, with the exception of manganese ore, barytes, mica, slate, and "all other minerals," the value of the products of the incorporated companies was far in excess of that shown for the other forms of ownership. In the majority of cases it was more than double the value of products reported for either individuals or firms.

The great increase in the consumption of coal and the demand for raw material to meet the requirements of manufactures has resulted in a general and extensive development of the mining industries, especially those for which the deposits are confined to well-defined geographic districts. Extensive mining operations can be carried on successfully only by the employment of large capital, and the incorporated form of ownership is the most convenient method of raising such capital. Incorporated companies organized primarily for manufacturing enterprises frequently engage in mining in order to control the supply of raw material and to enable themselves to practice economy in production. The production of borax, molybdenum, and rutile was controlled entirely by incorporated companies during the census year.

The incorporated form of ownership in all branches of minerals is of such overwhelming importance that the statistics for employees, salaries, wages, expenses, and products for such companies are of great importance when compared with similar statistics for all other forms of ownership. The following table makes a comparison of this character for each class and for the different groups of minerals:

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902.

[Exclusive of petroleum.]

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	32,845	17,318	35,095	$36,033,784	564,176	$356,717,569	$7,721,307	$55,959,987	$106,033,455	$725,128,668
Incorporated	19,539	4,951	29,429	$31,737,061	479,618	$306,369,622	$7,070,682	$49,707,399	$93,115,790	$625,832,355
Per cent of total	59.5	28.6	83.9	88.1	85.0	85.9	91.6	88.9	87.8	86.3
Unincorporated	13,306	12,367	5,666	$4,296,723	84,558	$50,347,947	$650,625	$6,252,588	$12,917,665	$99,296,313
Per cent of total	40.5	71.4	16.1	11.9	15.0	14.1	8.4	11.1	12.2	13.7
Metallic	4,280	4,081	8,138	$9,948,335	110,404	$81,046,324	$1,371,921	$17,168,321	$39,639,703	$215,453,587
Incorporated	1,762	1,579	7,036	$8,946,198	98,837	$71,888,155	$1,196,732	$15,074,915	$36,103,550	$192,297,393
Per cent of total	41.2	38.7	86.5	89.9	89.5	89.1	87.2	87.8	91.1	89.3
Unincorporated	2,518	2,502	1,102	$1,002,137	11,567	$9,158,169	$175,189	$2,093,406	$3,536,153	$23,156,194
Per cent of total	58.8	61.3	13.5	10.1	10.5	10.9	12.8	12.2	8.9	10.7
Copper ore	144	144	1,208	$1,768,156	26,167	$21,151,405	$188,768	$1,397,465	$11,083,175	$51,178,036
Incorporated	100	100	1,163	$1,717,966	25,616	$20,579,298	$183,568	$1,358,761	$10,809,965	$50,421,837
Per cent of total	69.4	69.4	96.3	97.1	97.9	97.3	97.2	97.2	97.5	98.5
Unincorporated	44	44	45	$50,190	551	$572,107	$5,200	$38,704	$273,210	$756,199
Per cent of total	30.6	30.6	3.7	2.9	2.1	2.7	2.8	2.8	2.5	1.5
Gold and silver	2,992	2,992	3,480	$5,076,773	36,142	$36,077,492	$626,090	$5,357,329	$16,699,768	$82,482,052
Incorporated	1,079	1,079	2,964	$4,444,818	30,217	$30,054,790	$521,921	$4,419,837	$14,677,977	$68,327,754
Per cent of total	36.1	36.1	85.2	87.6	83.6	83.3	83.4	82.5	87.9	82.8
Unincorporated	1,913	1,913	516	$631,955	5,925	$6,022,702	$104,169	$937,492	$2,021,791	$14,154,298
Per cent of total	63.9	63.9	14.8	12.4	16.4	16.7	16.6	17.5	12.1	17.2
Iron ore	525	332	2,405	$2,113,230	38,851	$21,531,792	$425,292	$8,257,714	$9,005,608	$65,465,321
Incorporated	392	214	2,212	$2,000,456	36,316	$20,504,967	$418,176	$8,144,782	$8,538,596	$63,303,407
Per cent of total	74.7	64.5	92.0	94.7	93.5	95.2	98.3	98.6	94.8	96.7
Unincorporated	133	118	193	$112,774	2,535	$1,026,825	$7,116	$112,932	$467,012	$2,161,914
Per cent of total	25.3	35.5	8.0	5.3	6.5	4.8	1.7	1.4	5.2	3.3
Lead and zinc ore	559	557	910	$826,327	7,881	$4,329,271	$108,607	$2,092,004	$2,511,637	$14,600,177
Incorporated	161	159	581	$634,177	5,541	$2,928,788	$49,903	$1,096,168	$1,771,672	$8,823,159
Per cent of total	28.8	28.5	63.8	76.7	70.3	67.7	45.9	52.4	70.5	60.4
Unincorporated	398	398	329	$192,150	2,340	$1,400,483	$58,704	$995,836	$739,965	$5,777,018
Per cent of total	71.2	71.5	36.2	23.3	29.7	32.3	54.1	47.6	29.5	39.6
Manganese ore	19	19	18	$9,395	194	$74,924	....	$3,845	$17,228	$177,911
Incorporated	6	6	10	$4,605	107	$37,264	....	$1,540	$9,357	$20,352
Per cent of total	31.6	31.6	55.6	49.0	55.2	49.7	....	40.1	54.3	11.4
Unincorporated	13	13	8	$4,790	87	$37,660	....	$2,305	$7,871	$157,559
Per cent of total	68.4	68.4	44.4	51.0	44.8	50.3	....	59.9	45.7	88.6
Quicksilver	41	37	117	$154,154	1,329	$881,340	$23,164	$59,767	$322,267	$1,550,090
Incorporated	24	21	106	$144,176	1,200	$784,028	$23,164	$53,827	$295,982	$1,400,884
Per cent of total	58.5	56.8	90.6	93.5	90.3	89.0	100.0	90.1	91.8	90.4
Unincorporated	17	16	11	$9,978	129	$97,312	....	$5,940	$26,285	$149,206
Per cent of total	41.5	43.2	9.4	6.5	9.7	11.0	....	9.9	8.2	9.6
Fuels	21,792	6,177	19,350	$19,229,894	355,007	$223,134,680	$6,109,736	$31,969,555	$44,146,957	$397,899,932
Incorporated	16,330	1,926	17,198	$17,561,918	317,121	$200,161,868	$5,678,086	$29,401,865	$39,387,662	$356,399,452
Per cent of total	74.9	31.2	88.9	91.3	89.3	89.7	92.9	91.9	89.2	89.6
Unincorporated	5,462	4,251	2,152	$1,667,976	37,886	$22,972,812	$431,650	$2,567,690	$4,759,295	$41,500,480
Per cent of total	25.1	68.8	11.1	8.7	10.7	10.3	7.1	8.1	10.8	10.4
Coal, anthracite	334	119	3,014	$2,907,293	69,691	$38,716,113	$406,421	$9,307,239	$12,740,780	$76,173,586
Incorporated	285	76	2,679	$2,622,438	63,317	$35,461,348	$402,867	$8,439,021	$11,568,788	$69,209,224
Per cent of total	85.3	63.9	88.9	90.2	90.9	91.6	99.1	90.7	90.8	90.9
Unincorporated	49	43	335	$284,855	6,374	$3,254,765	$3,554	$868,218	$1,171,992	$6,964,362
Per cent of total	14.7	36.1	11.1	9.8	9.1	8.4	0.9	9.3	9.2	9.1
Coal, bituminous	5,652	4,409	14,415	$14,511,924	280,638	$181,482,298	$1,244,114	$16,774,459	$24,798,922	$290,858,483
Incorporated	2,618	1,517	12,680	$13,167,415	249,280	$161,869,608	$1,169,186	$15,156,519	$21,427,969	$257,639,338
Per cent of total	46.3	34.4	88.0	90.7	88.8	89.2	94.0	90.4	86.4	88.6
Unincorporated	3,034	2,892	1,735	$1,344,509	31,358	$19,612,690	$74,928	$1,617,940	$3,370,953	$33,219,145
Per cent of total	53.7	65.6	12.0	9.3	11.2	10.8	6.0	9.6	13.6	11.4
Natural gas	15,806	1,949	1,923	$1,810,337	4,678	$2,906,279	$4,459,001	$5,912,257	$6,607,255	$30,867,863
Incorporated	13,427	633	1,839	$1,775,095	4,524	$2,800,922	$4,106,033	$5,809,325	$6,390,906	$29,550,890
Per cent of total	84.9	32.5	95.6	98.1	96.7	96.4	92.1	98.3	96.7	95.7
Unincorporated	2,379	1,316	84	$35,242	154	$105,357	$352,968	$102,932	$216,349	$1,316,973
Per cent of total	15.1	67.5	4.4	1.9	3.3	3.6	7.9	1.7	3.3	4.3
Structural materials	6,044	5,746	6,342	$5,690,130	86,295	$44,654,537	$60,749	$5,750,482	$20,072,399	$96,370,559
Incorporated	1,060	879	4,101	$4,170,905	53,589	$27,390,121	$29,928	$4,385,332	$15,689,116	$64,208,623
Per cent of total	17.5	15.3	64.7	73.3	62.1	61.3	49.3	76.3	78.2	66.6
Unincorporated	4,984	4,867	2,241	$1,519,225	32,706	$17,264,416	$30,821	$1,365,150	$4,383,283	$32,161,936
Per cent of total	82.5	84.7	35.3	26.7	37.9	38.7	50.7	23.7	21.8	33.4
Cement	101	93	913	$1,087,514	13,041	$6,328,852	$10,627	$1,665,520	$9,098,226	$24,268,338
Incorporated	91	83	891	$1,072,926	12,861	$6,242,950	$10,627	$1,654,230	$9,048,502	$24,086,747
Per cent of total	90.1	89.2	97.6	98.7	98.6	98.6	100.0	99.3	99.5	99.3
Unincorporated	10	10	22	$14,588	180	$85,902	....	$11,290	$49,724	$181,591
Per cent of total	9.9	10.8	2.4	1.3	1.4	1.4	....	0.7	0.5	0.7
Clay	205	203	185	$150,505	2,433	$958,892	$13,241	$126,873	$272,823	$2,061,072
Incorporated	53	52	116	$110,655	1,160	$420,514	$4,025	$71,369	$172,258	$1,000,077
Per cent of total	25.9	25.6	62.7	73.5	47.7	43.9	30.4	56.3	63.1	48.5
Unincorporated	152	151	69	$39,850	1,273	$538,378	$9,216	$55,504	$100,565	$1,060,995
Per cent of total	74.1	74.4	37.3	26.5	52.3	56.1	69.6	43.7	36.9	51.5
Limestones and dolomites	3,246	3,137	2,231	$1,843,747	31,547	$14,750,638	$36,381	$1,440,081	$5,403,912	$30,441,801
Incorporated	439	344	1,384	$1,312,251	18,757	$8,847,313	$15,276	$960,286	$3,421,224	$18,216,602
Per cent of total	13.5	11.0	62.0	71.2	59.5	60.0	42.0	66.7	63.1	59.8
Unincorporated	2,807	2,793	847	$531,496	12,790	$5,903,325	$21,105	$479,795	$1,982,688	$12,225,199
Per cent of total	86.5	89.0	38.0	28.8	40.5	40.0	58.0	33.3	36.9	40.2
Marble	83	75	352	$341,021	4,070	$2,212,640	....	$382,877	$825,822	$5,044,182
Incorporated	53	45	310	$308,767	3,545	$1,913,820	....	$362,662	$735,448	$4,469,791
Per cent of total	63.9	60.0	88.1	90.5	87.1	86.5	....	94.7	89.1	88.6
Unincorporated	30	30	42	$32,254	525	$298,820	....	$20,215	$90,374	$574,391
Per cent of total	36.1	40.0	11.9	9.5	12.9	13.5	....	5.3	10.9	11.4

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902—Continued.

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Structural materials—Continued.										
Sandstones and quartzites	1,304	1,211	847	$713,579	10,448	$6,153,060	$500	$878,780	$1,298,190	$10,601,171
Incorporated	146	119	422	$431,484	4,920	$2,831,472		$610,099	$796,557	$4,759,148
Per cent of total	11.2	9.8	49.8	60.5	47.1	46.0		69.4	61.4	44.9
Unincorporated	1,158	1,092	425	$282,095	5,528	$3,322,588	$500	$268,681	$501,633	$5,842,023
Per cent of total	88.8	90.2	50.2	39.5	52.9	54.0	100.0	30.6	38.6	55.1
Siliceous crystalline rocks	906	853	1,377	$1,227,885	18,836	$11,072,996		$810,206	$2,493,065	$18,257,944
Incorporated	212	176	728	$741,731	9,585	$5,683,837		$493,946	$1,175,879	$9,030,876
Per cent of total	23.4	20.6	52.9	60.4	50.9	51.3		61.0	47.2	49.5
Unincorporated	694	677	649	$486,154	9,251	$5,389,159		$316,260	$1,317,186	$9,227,068
Per cent of total	76.6	79.4	47.1	39.6	49.1	48.7		39.0	52.8	50.5
Slate	199	174	437	$334,879	5,920	$3,177,459		$446,145	$680,361	$5,696,051
Incorporated	66	60	250	$202,091	2,761	$1,451,215		$232,740	$349,248	$2,645,387
Per cent of total	33.2	34.5	57.2	60.3	46.6	45.7		52.2	51.3	46.4
Unincorporated	133	114	187	$132,788	3,159	$1,726,244		$213,405	$331,113	$3,050,664
Per cent of total	66.8	65.5	42.8	39.7	53.4	54.3		47.8	48.7	53.6
Abrasive materials	82	75	75	$48,008	610	$296,914		$42,410	$80,309	$1,177,711
Incorporated	25	19	51	$34,116	369	$181,028		$33,770	$64,245	$890,392
Per cent of total	30.5	25.3	68.0	71.1	60.5	61.0		79.6	80.0	75.6
Unincorporated	57	56	24	$13,892	241	$115,886		$8,640	$16,064	$287,319
Per cent of total	69.5	74.7	32.0	28.9	39.5	39.0		20.4	20.0	24.4
Buhrstones and millstones	29	29	7	$1,682	86	$39,562		$1,480	$1,809	$59,808
Incorporated										
Per cent of total										
Unincorporated	29	29	7	$1,682	86	$39,562		$1,480	$1,809	$59,808
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0
Corundum and emery; crystalline quartz; and oilstones, whetstones, and scythestones	26	20	23	$17,090	161	$84,440		$9,282	$34,726	$261,658
Incorporated	14	8	21	$16,316	126	$70,686		$8,522	$32,481	$185,886
Per cent of total	53.8	40.0	91.3	95.5	78.3	83.7		91.8	93.5	71.0
Unincorporated	12	12	2	$774	35	$13,754		$760	$2,245	$75,772
Per cent of total	46.2	60.0	8.7	4.5	21.7	16.3		8.2	6.5	29.0
Garnet	7	7	12	$9,178	118	$59,632		$4,952	$10,128	$132,820
Incorporated	3	3	5	$4,040	37	$13,503		$775	$1,511	$27,900
Per cent of total	42.9	42.9	41.7	44.0	31.4	22.6		15.7	14.9	21.0
Unincorporated	4	4	7	$5,138	81	$46,129		$4,177	$8,617	$104,920
Per cent of total	57.1	57.1	58.3	56.0	68.6	77.4		84.3	85.1	79.0
Grindstones and pulpstones	9	9	25	$13,042	210	$99,598		$24,433	$31,349	$667,431
Incorporated	5	5	22	$12,180	182	$87,349		$23,123	$29,953	$646,007
Per cent of total	55.6	55.6	88.0	93.4	86.7	87.7		94.6	95.5	96.8
Unincorporated	4	4	3	$862	28	$12,249		$1,310	$1,396	$21,424
Per cent of total	44.4	44.4	12.0	6.6	13.3	12.3		5.4	4.5	3.2
Infusorial earth, tripoli, and pumice	11	10	8	$4,016	35	$13,682		$2,263	$2,287	$55,994
Incorporated	3	3	3	$1,580	24	$9,490		$1,350	$300	$30,599
Per cent of total	27.3	30.0	37.5	39.3	68.6	69.4		59.7	13.1	54.6
Unincorporated	8	7	5	$2,436	11	$4,192		$913	$1,987	$25,395
Per cent of total	72.7	70.0	62.5	60.7	31.4	30.6		40.3	86.9	45.4
Chemical materials	228	174	750	$750,953	8,835	$3,313,088	$161,695	$741,570	$1,603,348	$10,618,669
Incorporated	156	116	676	$695,767	7,481	$2,824,374	$149,855	$651,078	$1,464,224	$9,372,632
Per cent of total	68.4	66.7	90.1	92.7	84.7	85.2	92.7	87.8	91.3	88.3
Unincorporated	72	58	74	$55,186	1,354	$488,714	$11,840	$90,492	$139,124	$1,246,037
Per cent of total	31.6	33.3	9.9	7.3	15.3	14.8	7.3	12.2	8.7	11.7
Borax	6	6	14	$18,128	153	$114,865		$47,606	$213,558	$2,383,614
Incorporated	6	6	14	$18,128	153	$114,865		$47,606	$213,558	$2,383,614
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0
Unincorporated										
Per cent of total										
Fluorspar	22	18	42	$27,311	269	$110,002	$300	$23,602	$31,374	$275,682
Incorporated	18	14	35	$23,914	215	$87,605	$300	$23,352	$14,942	$216,160
Per cent of total	81.8	77.8	83.3	87.6	79.9	79.6	100.0	98.9	47.6	78.4
Unincorporated	4	4	7	$3,397	54	$22,397		$250	$16,432	$59,522
Per cent of total	18.2	22.2	16.7	12.4	20.1	20.4		1.1	52.4	21.6
Gypsum	62	45	249	$239,420	1,472	$759,258	$406	$200,769	$341,760	$2,089,341
Incorporated	43	26	243	$235,428	1,405	$714,043		$193,920	$322,076	$1,947,641
Per cent of total	69.4	57.8	97.6	98.3	95.4	94.0		96.6	94.2	93.2
Unincorporated	19	19	6	$3,992	67	$45,215	$406	$6,849	$19,684	$141,700
Per cent of total	30.6	42.2	2.4	1.7	4.6	6.0	100.0	3.4	5.8	6.8
Phosphate rock	115	87	391	$355,204	5,971	$1,930,093	$157,402	$430,475	$799,414	$4,922,943
Incorporated	70	56	341	$316,925	4,899	$1,572,841	$147,102	$347,795	$714,070	$3,986,923
Per cent of total	60.9	64.4	87.2	89.2	82.0	81.5	93.5	80.8	89.3	81.0
Unincorporated	45	31	50	$38,279	1,072	$357,252	$10,300	$82,680	$85,344	$936,020
Per cent of total	39.1	35.6	12.8	10.8	18.0	18.5	6.5	19.2	10.7	19.0
Sulphur and pyrite	23	18	54	$49,890	970	$398,870	$3,587	$39,118	$217,262	$947,089
Incorporated	19	14	43	$41,372	809	$335,027	$2,453	$38,405	$199,598	$838,294
Per cent of total	82.6	77.8	79.6	82.9	83.4	84.0	68.4	98.2	91.9	88.5
Unincorporated	4	4	11	$8,518	161	$63,843	$1,134	$713	$17,664	$108,795
Per cent of total	17.4	22.2	20.4	17.1	16.6	16.0	31.6	1.8	8.1	11.5
Pigments	84	77	91	$68,752	592	$236,372	$1,000	$60,448	$65,845	$564,039
Incorporated	29	28	75	$60,451	286	$109,480		$36,469	$51,140	$371,651
Per cent of total	34.5	36.4	82.4	87.9	48.3	46.3		60.3	77.7	65.9
Unincorporated	55	49	16	$8,301	306	$126,892	$1,000	$23,979	$14,705	$192,388
Per cent of total	65.5	63.6	17.6	12.1	51.7	53.7	100.0	39.7	22.3	34.1

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902—Continued.

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Pigments—Continued.										
Barytes	49	42	28	$15,159	336	$126,285	$1,000	$35,555	$7,772	$203,154
Incorporated	7	6	18	$11,608	79	$25,904	......	$13,850	$3,467	$75,037
Per cent of total	14.3	14.3	64.3	76.6	23.5	19.9	......	39.0	44.6	36.9
Unincorporated	42	36	10	$3,551	257	$101,381	$1,000	$21,705	$4,305	$128,117
Per cent of total	85.7	85.7	35.7	23.4	76.5	80.1	100.0	61.0	55.4	63.1
Mineral pigments, crude	35	35	63	$53,593	256	$106,087	......	$24,893	$58,073	$360,885
Incorporated	22	22	57	$48,843	207	$83,576	......	$22,619	$47,673	$296,644
Per cent of total	62.9	62.9	90.5	91.1	80.9	78.8	......	90.9	82.1	82.2
Unincorporated	13	13	6	$4,750	49	$22,511	......	$2,274	$10,400	$64,241
Per cent of total	37.1	37.1	9.5	8.9	19.1	21.2	......	9.1	17.9	17.8
Miscellaneous	335	688	349	$289,052	2,433	$1,035,784	$16,406	$202,801	$424,894	$3,344,181
Incorporated	177	104	292	$255,676	1,935	$814,616	$16,081	$170,970	$355,852	$2,592,192
Per cent of total	52.8	15.1	83.7	88.5	79.5	78.6	98.0	84.3	83.8	77.5
Unincorporated	158	584	57	$33,376	498	$221,168	$325	$31,831	$69,042	$751,989
Per cent of total	47.2	84.9	16.3	11.5	20.5	21.4	2.0	15.7	16.2	22.5
Asbestos; bauxite; fuller's earth, marl; and monazite	80	48	68	$50,058	388	$131,875	$4,521	$22,244	$80,229	$349,451
Incorporated	45	14	66	$49,270	346	$118,312	$4,521	$19,775	$78,413	$308,964
Per cent of total	56.3	29.2	97.1	98.4	89.2	89.7	100.0	88.9	97.7	88.4
Unincorporated	35	34	2	$788	42	$13,563	......	$2,469	$1,816	$40,487
Per cent of total	43.7	70.8	2.9	1.6	10.8	10.3	......	11.1	2.3	11.6
Asphaltum and bituminous rock	24	24	52	$48,233	156	$79,570	$10,060	$19,753	$21,928	$236,728
Incorporated	19	19	50	$47,483	139	$68,738	$10,060	$19,528	$20,328	$201,346
Per cent of total	79.2	79.2	96.2	98.4	89.1	86.4	100.0	98.9	92.7	85.1
Unincorporated	5	5	2	$750	17	$10,832	......	$225	$1,600	$35,382
Per cent of total	20.8	20.8	3.8	1.6	10.9	13.6	......	1.1	7.3	14.9
Feldspar	27	26	27	$20,095	252	$107,444	......	$19,407	$50,278	$250,424
Incorporated	9	8	17	$15,563	181	$75,626	......	$12,996	$41,821	$159,160
Per cent of total	33.3	30.8	63.0	77.4	71.8	70.4	......	67.0	83.2	63.6
Unincorporated	18	18	10	$4,532	71	$31,818	......	$6,411	$8,457	$91,264
Per cent of total	66.7	69.2	37.0	22.6	28.2	29.6	......	33.0	16.8	36.4
Flint	19	17	18	$14,330	119	$47,454	......	$14,291	$18,642	$144,209
Incorporated	5	3	13	$12,130	88	$32,866	......	$9,447	$14,216	$93,651
Per cent of total	26.3	17.6	72.2	84.6	73.9	69.3	......	66.1	76.3	64.9
Unincorporated	14	14	5	$2,200	31	$14,588	......	$4,844	$4,426	$50,558
Per cent of total	73.7	82.4	27.8	15.4	26.1	30.7	......	33.9	23.7	35.1
Graphite	28	19	27	$18,924	164	$76,729	$900	$6,039	$51,840	$227,508
Incorporated	24	15	21	$16,569	138	$67,391	$900	$5,634	$50,573	$221,508
Per cent of total	85.7	78.9	77.8	87.6	84.1	87.8	100.0	93.3	97.6	97.4
Unincorporated	4	4	6	$2,355	26	$9,338	......	$405	$1,267	$6,000
Per cent of total	14.3	21.1	22.2	12.4	15.9	12.2	......	6.7	2.4	2.6
Lithium ore	3	3	1	$600	6	$3,711	......	$200	$1,265	$25,750
Incorporated	......	......	......	......	......	......	......	......	......	......
Per cent of total	......	......	......	......	......	......	......	......	......	......
Unincorporated	3	3	1	$600	6	$3,711	......	$200	$1,265	$25,750
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	......	100.0	100.0	100.0
Mica	49	38	21	$13,444	98	$44,043	......	$12,914	$11,961	$118,849
Incorporated	18	9	17	$11,853	50	$28,400	......	$9,445	$9,036	$49,165
Per cent of total	36.7	23.7	81.0	88.2	51.0	64.5	......	73.1	75.5	41.4
Unincorporated	31	29	4	$1,591	48	$15,643	......	$3,469	$2,925	$69,684
Per cent of total	63.3	76.3	19.0	11.8	49.0	35.5	......	26.9	24.5	58.6
Precious stones	46	460	22	$28,687	108	$88,017	......	$7,481	$17,781	$328,450
Incorporated	27	10	17	$22,000	92	$76,938	......	$5,795	$14,289	$205,790
Per cent of total	58.7	2.2	77.3	76.7	85.2	87.4	......	77.5	80.4	62.7
Unincorporated	19	450	5	$6,687	16	$11,079	......	$1,686	$3,492	$122,660
Per cent of total	41.3	97.8	22.7	23.3	14.8	12.6	......	22.5	19.6	37.3
Silica sand	26	20	35	$27,228	335	$149,114	$100	$18,776	$38,386	$421,289
Incorporated	14	10	21	$18,285	173	$81,696	$100	$10,763	$16,704	$248,767
Per cent of total	53.8	50.0	60.0	67.2	51.6	54.8	100.0	57.3	43.5	59.0
Unincorporated	12	10	14	$8,943	162	$67,418	......	$8,013	$21,682	$172,522
Per cent of total	46.2	50.0	40.0	32.8	48.4	45.2	......	42.7	56.5	41.0
Talc and soapstone	20	20	75	$63,713	771	$279,083	......	$80,136	$125,932	$1,138,167
Incorporated	13	13	69	$62,283	726	$263,613	......	$77,462	$110,090	$1,079,591
Per cent of total	65.0	65.0	92.0	97.8	94.2	94.5	......	96.7	87.4	94.9
Unincorporated	7	7	6	$1,430	45	$15,470	......	$2,674	$15,842	$58,576
Per cent of total	35.0	35.0	8.0	2.2	5.8	5.5	......	3.3	12.6	5.1
Tungsten	4	4	......	......	2	$1,200	......	$120	$210	$5,975
Incorporated	......	......	......	......	......	......	......	......	......	......
Per cent of total	......	......	......	......	......	......	......	......	......	......
Unincorporated	4	4	......	......	2	$1,200	......	$120	$210	$5,975
Per cent of total	100.0	100.0	......	......	100.0	100.0	......	100.0	100.0	100.0
Uranium and vanadium	3	3	2	$3,500	19	$17,040	......	$490	$3,010	$48,125
Incorporated	......	......	......	......	......	......	......	......	......	......
Per cent of total	......	......	......	......	......	......	......	......	......	......
Unincorporated	3	3	2	$3,500	19	$17,040	......	$490	$3,010	$48,125
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	......	100.0	100.0	100.0
All other minerals	6	6	1	$240	15	$10,411	$825	$950	$3,452	$49,256
Incorporated	3	3	1	$240	2	$1,036	$500	$125	$382	$24,250
Per cent of total	50.0	50.0	100.0	100.0	13.3	10.0	60.6	13.2	11.1	49.2
Unincorporated	3	3	......	......	13	$9,375	$325	$825	$3,070	$25,006
Per cent of total	50.0	50.0	......	......	86.7	90.0	39.4	86.8	88.9	50.8

To avoid disclosing the operations of individual establishments it was necessary to combine in Table 23 the statistics for corundum and emery, crystalline quartz, oilstones, whetstones, and scythestones, and asbestos, bauxite, fuller's earth, marl, and monazite.

While the number of incorporated companies (4,951) formed only 28.6 per cent of the total number of operators, they gave employment to 479,618, or 85 per cent of the wage-earners, and paid $306,369,622, or 85.9 per cent of the total wages paid by all operators. These companies also paid $49,707,399, or 88.9 per cent of the miscellaneous expenses, and the cost of their supplies and materials reached $93,115,790, or 87.8 per cent of the total cost, while the value of their products, amounting to $626,132,335, was 86.3 per cent of the value of products for all mines, quarries, and wells.

Incorporated companies have assumed the greatest importance in the production of ores. They employed 98,837, or 89.5 per cent of the wage-earners in the metallic group and paid them $74,888,135, or 89.1 per cent of the wages. The products were valued at $192,297,393, forming 89.3 per cent of the total value of products in this group.

Practically the entire production of copper ore was under the control of incorporated companies, these companies employing 97.9 per cent of the wage-earners and reporting 98.5 per cent of the total value of products for this mineral. Only 144 operators were reported for this mineral and but 44 of them were unincorporated, their product forming only 1.5 per cent of the total value of the product. In the metallic group of minerals iron ore stands next to copper in the part played by incorporated companies, this form of ownership giving employment to 36,316, or 93.5 per cent of the wage-earners and reported products valued at 96.7 per cent of the total value of products for this mineral. The large number of small operators engaged in the production of lead and zinc ore in Missouri and in the production of precious metals throughout the Western states reduced the comparative importance of incorporated companies in the production of these minerals. Manganese ore was the only exception to the predominance of the corporation in the production of ores. The production of this mineral is still largely under the control of individuals and firms.

Next in importance to the ores, in the production by the incorporated form of ownership is the group of minerals classed as fuels. In the foregoing table the statistics for fuels do not include the production of petroleum. Of the 6,477 operators reported for anthracite and bituminous coal mines and natural-gas wells, only 2,226, or 34.4 per cent, were incorporated companies. These companies, however, gave employment to 317,121, or 89.3 per cent, of the 355,007 wage-earners, and their products, valued at $356,399,452, formed 89.6 per cent of the total value of products for this mineral. In this group the predominance of the incorporated form of ownership was especially pronounced in the production of natural gas, the incorporated companies employing 96.7 per cent of the total number of wage-earners, and producing 95.7 per cent of the total products. In the production of anthracite coal, 76 incorporated companies, forming 63.9 per cent of the operators, employed 63,317, or 90.9 per cent, of the wage-earners, and their products, valued at $69,209,224, formed 90.9 per cent of the total value of the products of the industry. The 1,517 incorporated companies engaged in the mining of bituminous coal gave employment to 249,280, or 88.8 per cent, of the wage-earners, and the value of their products, amounting to $257,639,338, formed 88.6 per cent of the total value of bituminous coal mined during the year.

Of the 5,746 operators reported for structural materials, 879, or only 15.3 per cent, were incorporated companies. This comparatively small proportion of incorporated operators controlled considerably more than half of the industry. Their wage-earners, numbering 53,589, formed 62.1 per cent of all wage-earners, and their products, valued at $64,208,623, formed 66.6 per cent of the products. Of the different classes of minerals included in this group the incorporated form of ownership predominated for cement, limestones and dolomites, and marble. The manufacture of cement reported by the Census was confined to establishments operating quarries. Practically the entire output obtained in this manner was produced by incorporated companies. These companies gave employment to 98.6 per cent of the wage-earners engaged in the industry, and their production formed 99.3 per cent of the value of the products. Only 10 of the 93 operators were unincorporated, and their production formed only seven-tenths of 1 per cent of the total value of the product for the industry.

The incorporated companies engaged in the production of limestones and dolomites gave employment to 59.5 per cent of the wage-earners reported for all quarries devoted to the production of these stones, and in value their products formed 59.8 per cent of the total. A greater preponderance of the incorporated form of ownership is shown for marble, the incorporated companies in this industry employing 87.1 per cent of the wage-earners, and reporting 88.6 per cent of the total value of products.

The production of clay reported by the Bureau of the Census was confined to the products sold as such, and did not include the manufacture of brick and pottery products. While the number of wage-earners and the value of the product reported for the unincorporated operators engaged in clay mining and in the quarrying of sandstones and quartzites, siliceous crystalline rocks, and slate, were slightly in excess of those reported for incorporated companies, the indications are that the incorporated form of ownership is assuming control of these industries.

The mines engaged in the production of abrasive materials and controlled by incorporated companies gave employment to 60.5 per cent of the wage-earners reported for this group, and their products formed 75.6 per cent of the total value. Only 29 quarries were reported as engaged in the production of buhrstones and millstones as their principal products. Twenty-three of these quarries were operated under the individual form of ownership and 6 by firms or partnerships. The larger proportion of buhrstones and millstones was obtained from sandstone quarries, which are included under the group of structural materials. The figures in Table 23, therefore, do not indicate the proportion of the products of this class obtained from quarries operated by incorporated companies. The incorporated form of ownership predominated in all of the other minerals included in the group of abrasive materials with the exception of garnet. In the case of garnet 3 of the 7 operators were incorporated, and they reported a product valued at $27,900, or 21 per cent of the total for this mineral.

The production of chemical materials shows a decided preponderance in favor of the incorporated form of ownership, over 78 per cent of the production of each mineral being reported by incorporated companies. Taking this group as a whole, the corporations—116 out of the 174 producers—employed 84.7 per cent of the wage-earners, paid 85.2 per cent of the wages, and reported 88.3 per cent of the total value of the product.

Of the 77 producers of pigments, 28 were incorporated. These incorporated com anies employed 286, or 48.3 per cent, of the 592 wage-earners, and paid $109,480, or 46.3 per cent, of the wages, and their products amounted to $371,651, or 65.9 per cent, of the total for the group.

The miscellaneous group of minerals, taken as a whole, shows that the business of incorporated operators predominated in the proportion of about 3 to 1. They constituted 15.1 per cent of the 688 producers, employed 79.5 per cent of the 2,433 wage-earners, paid 78.6 per cent of the $1,035,784 paid in wages, and reported a product valued at $2,592,192, or 77.5 per cent, of the total for the group.

Petroleum.—As previously explained, the character of ownership was not reported for 28,924 operators engaged in the production of petroleum, and for this reason the data were excluded from the preceding tables. In the following table the report for the Standard Oil Company has been considered as that of an incorporated company covering the operations of 28,924 other operators. While this rearrangement does not show the true character of the ownership of the individual operators, it probably conveys an accurate idea of the actual control of the production.

TABLE 24.—*Summary for petroleum for incorporated and unincorporated operators: 1902.*

	Total.	Incorporated companies.	Per cent of total.	Unincorporated operators.	Per cent of total.
Number of wells	118,671	116,307	98.0	2,364	2.0
Number of operators	598	414	69.2	184	30.8
Salaried officials, clerks, etc.:					
Number	3,033	2,323	76.6	710	23.4
Salaries	$2,986,768	$2,927,423	98.0	$59,345	2.0
Wage-earners:					
Average number	17,552	17,350	98.8	202	1.2
Wages	$13,242,361	$13,045,370	98.5	$196,991	1.5
Contract work	$12,956,631	$12,465,386	96.2	$491,245	3.8
Miscellaneous expenses	$15,811,726	$15,651,684	99.0	$160,042	1.0
Cost of supplies and materials	$17,781,512	$17,398,757	97.8	$382,755	2.2
Value of product	$71,397,739	$69,920,060	97.9	$1,477,679	2.1

The operators included as incorporated companies in the above table and engaged in the production of petroleum gave employment to 17,350, or 98.8 per cent, of the wage-earners, and their wages amounted to $13,045,370, or 98.5 per cent, of the total wages paid in the industry. Their products were valued at $69,920,060, or 97.9 per cent, of the total value of product.

Industrial combinations.—The statistics presented in the preceding section indicate the extent to which the firm and the incorporated company have assumed control of the mining industries. The exigencies of production on a large scale and the desirability of controlling all or a large portion of the deposits of certain minerals, combined with the advantages of carrying on mining and manufacturing under the same management and with the use of the same capital, have led to the consolidation of formerly independent operators and the formation of what are commonly known as industrial combinations. Such combinations are a form of incorporated ownership, and the statistics for them should be considered in connection with those for incorporated companies. This form of ownership has assumed large proportions in the manufacturing industries. In presenting the statistics of combinations in these industries the following definition was given in the report of the Twelfth Census on manufactures:

> For the purpose of the Census the rule has been adopted to consider no aggregation of mills an industrial combination unless it consists of a number of formerly independent mills which have been brought together into one company under a charter obtained for that purpose. We therefore exclude from this category many large establishments comprising a number of mills which have grown up, not by combination with other mills, but by the erection of new plants or the purchase of old ones.
>
> The word "trust" was avoided in this definition, because, while it may have come to convey to the popular mind a definite idea, it stands technically for a form of organization under which the stockholders of each of the separate companies assign their stock to a certain number of trustees, thus giving to these trustees an irrevocable power of attorney to vote the stock as they see fit. This form of organization has been declared illegal by the act of July 2, 1890, Fifty-first Congress, first session, entitled "An act to protect trade and commerce against unlawful restraint of monopolies" (26 Statutes at Large, page 209), and by the statutes of many states.

While the compilation of statistics for manufactures in conformity with this definition resulted in the presentation of totals which show the extent to which formerly independent establishments have come under the same ownership, and the magnitude of their operations, they do not show the extent to which the production has become concentrated in fewer establishments. In order to show such concentration it is necessary to consider all large establishments, irrespective of the method of their formation, and this has been done for the mining industries in Sections V and VI of Chapter II. As the extent of the deposits of many minerals can be determined very accurately and the production controlled through their purchase, the mining industries hold out inducements which do not exist in other industries to the formation of industrial combinations or other forms of business organizations to control the production.

The operations of a number of corporations in the mining industry have acquired enormous proportions through the gradual purchase and development of new properties, and there are numerous cases of consolidation of small independent operators, especially in the production of gold, silver, lead, and zinc. While the object of these consolidations may sometimes be the reduction of operating expenses, such consolidations are frequently made with the intention of issuing a larger amount of capital stock than was possible under an independent form of organization. In many instances independent mining claims or prospects have been made the basis for the organization of corporations, and the claims have been capitalized on their possible production, although mining operations had not actually commenced at the time of the formation of the company.

The production of some minerals is probably controlled by a mutual understanding between the operators of the mines or between the operators and transportation companies, but it is impracticable to identify operations which are controlled by arrangements of this character.

A number of the companies included in the mining census were engaged in other industries, such as manufacturing or transportation; the mining operations were incidental to their other interests, and it was impossible to segregate the capitalization so as to assign a proper proportion to the mining interests. The Standard Oil Company, for example, is engaged primarily in the refining of petroleum and produces only a limited amount of crude material; but, as explained on page 20, this company made reports covering the operations of a large number of producers of petroleum. The United States Steel Corporation is engaged primarily in the manufacture of iron and steel products, but it also operates a number of iron ore and coal mines, limestone quarries, and natural gas wells, and its capitalization covers other interests. A number of large companies which are engaged extensively in manufacturing, as well as in mining and other industries, have reported their entire capitalization in reply to the inquiries on the mining schedule, together with all dividends and interest accrued from the profits of both the mining and manufacturing operations, declaring that it was impossible to make a separation. Notable among such companies are the Republic Iron and Steel Company, the Sloss-Sheffield Steel and Iron Company, the New Jersey Zinc Company, the Alabama Consolidated Coal and Iron Company, the Colorado Fuel and Iron Company, the Empire Steel and Iron Company, the Pacific Coast Company, the Philadelphia Company, the Tennessee Coal, Iron, and Railroad Company, and the Virginia Iron, Coal, and Coke Company. This is also true, to a greater or less degree, of most of the companies reporting capital stock, as a very small proportion of them confine their operations solely to mining.

It is evident, therefore, that while industrial combinations similar to those referred to in the report on manufactures of the Twelfth Census do exist in the mining industries, it is impracticable to compile satisfactory statistics for them. But eliminating from consideration the production of coal, petroleum, and natural gas, and compiling the statistics of the rest of the minerals in as close conformity as possible with the definition given above, it is found that industrial combinations exist in the production of several minerals. Table 25 shows for all the items discussed in this chapter the totals for all operators and for industrial combinations in the same minerals and the percentages that the industrial combinations are of the totals for all operators.

TABLE 25.—SUMMARY FOR MINERALS FOR WHICH INDUSTRIAL COMBINATIONS ARE REPORTED: 1902.

	Iron ore.	Copper ore.	Cement	Limestones and dolomites.	All other minerals.[1]
Number of mines, quarries, and wells:					
Total	525	144	101	3,246	2,904
Industrial combinations	118	21	17	46	72
Per cent of total	22.5	14.6	16.8	1.4	2.5
Salaried officials, clerks, etc.					
Number—					
Total	2,405	1,208	913	2,231	3,560
Industrial combinations	1,425	443	118	134	264
Per cent of total	59.3	36.7	12.9	6.0	7.4
Salaries—					
Total	$2,113,290	$1,768,456	$1,087,514	$1,843,747	$3,304,299
Industrial combinations	$1,254,157	$644,688	$191,312	$133,171	$333,169
Per cent of total	59.4	36.5	17.6	7.2	10.1
Wage-earners:					
Average number—					
Total	38,851	26,007	13,041	31,547	39,906
Industrial combinations	19,148	11,318	4,319	2,596	2,830
Per cent of total	49.3	43.5	33.1	8.2	7.1
Wages—					
Total	$21,531,792	$21,151,405	$6,328,852	$14,750,658	$22,843,684
Industrial combinations	$11,154,462	$9,787,476	$2,056,750	$1,113,299	$1,443,773
Per cent of total	51.8	46.3	32.5	7.5	6.3
Contract work:					
Total	$425,292	$188,768	$10,627	$36,381	$119,573
Industrial combinations	$148,726	$39,675			$2,000
Per cent of total	35.0	21.0			1.7
Miscellaneous expenses:					
Total	$8,257,714	$1,397,465	$1,665,520	$1,440,081	$4,113,410
Industrial combinations	$5,357,709	$445,344	$558,171	$59,459	$608,011
Per cent of total	64.9	31.9	33.5	4.2	14.7
Cost of supplies and materials:					
Total	$9,005,608	$11,093,175	$9,098,226	$5,403,912	$6,857,657
Industrial combinations	$4,842,372	$4,649,168	$3,461,249	$306,870	$669,528
Per cent of total	53.7	41.9	38.0	5.7	9.8
Value of product:					
Total	$65,465,321	$51,178,086	$24,268,338	$30,441,801	$47,809,532
Industrial combinations	$38,172,009	$28,502,848	$8,189,118	$2,091,225	$3,922,648
Per cent of total	58.3	55.7	33.7	6.9	8.2

[1] Includes asphaltum and bituminous rock, corundum and emery, grindstones and pulpstones, gypsum, lead and zinc ore, oilstones, whetstones, and scythestones, sandstones and quartzites, siliceous crystalline rocks, and talc and soapstone.

The operators classed as industrial combinations and engaged in the production of iron ore gave employment to 49.3 per cent of the wage-earners and in value their products formed 58.3 per cent of the total value of all the iron ore produced during the year. While only 14.6 per cent of the operators of copper mines were classed as industrial combinations, they gave employment to 43.5 per cent of the wage-earners and their products formed 55.7 per cent of the total value of products.

VII.

CAPITAL.

Reasons for not securing statistics.—It has been the practice at prior censuses to include in the report on mining industries statistics concerning capital invested. The object was to ascertain the value of all mining properties and money invested or used in the business, whether owned or borrowed. In order to develop these amounts the inquiries called for the value of the mine and improvements, including land, buildings, fixtures, tools, implements, live stock, machinery, etc., and were in harmony with those concerning capital included in the schedule for the manufacturing and mechanical industries, but the statistics for both branches of industry have frequently been referred to as untrustworthy and delusive. It is evident from the various inquiries made at the Eleventh Census[1] that uniform amounts were not reported for capital invested in all branches of the mining industry, and the statistics can not be accepted as representing the actual value of the mining properties or the amount of capital invested in the industry.

All of the objections to the statistics for capital in manufactures apply with greater force to the statistics for mines and quarries, and they may be summarized as follows:

1. It is impossible to define the word "capital" for statistical measurement so that it shall be tangible, restricted, and uniform.
2. The inquiry creates more prejudice and arouses more opposition to the progress of the enumeration than all of the other inquiries united.
3. The value of "fixed capital"—land and buildings—is dependent upon conditions of which a census can take no cognizance.
4. The difficulties attending the collection of statistics for live capital—"cash on hand, bills receivable, unsettled accounts, etc."—preclude the possibility of reliable results.
5. It is impossible to eliminate the duplication in gross assets and credit capital.
6. Good will, patents, mining rights, etc., are forms of capital for which no satisfactory value can be obtained.
7. Many mining companies have investments other than of the amounts required to carry on their business

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[1] The following indicates the character of the inquiries used at the Eleventh Census: For minor minerals the inquiries called for "total value of mine and improvements, as at present developed, distributed as follows: Land; buildings and fixtures; tools, implements, live stock, machinery, and supplies on hand; cash not reported in the foregoing items." The instructions required that the amount of capital should be stated so as to include not only the amount of capital actually invested in the business, as in land, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carry-

and yet constituting a part of their capital, such as railroads, steamships, and timber lands, and it is impossible to segregate the capital that pertains strictly to mining.

8. A number of mines are operated under leases. The lessees furnish the Census reports, but have no knowledge of the value of the mine or the capital invested by the lessor in land, shafts, machinery, etc.

9. The value of a mine is due chiefly to the character and amount of ore supposed to be in the earth, and is, therefore, largely speculative.

The act of Congress of March 3, 1899, was the first census law that specified the character of the inquiries to be embraced in the schedule for manufactures, and the "amount of capital invested" formed one of these inquiries. The same law provided for the census of mines, mining, and minerals, but in enumerating the different subjects to be included in the report, no reference was made to the capital invested. The absence of a definite provision of law and the unsatisfactory character of the statistics concerning capital collected at prior censuses, justified the omission of this inquiry from the mining census of 1902. The report for this census, therefore, contains no information concerning the value of the mining property or the actual amount of capital invested in the industry.

Capitalization of incorporated companies, by minerals.—Exclusive of the products of natural-gas and petroleum wells, 85.9 per cent of the mining products of the country during 1902 was produced by incorporated companies, and the prevalence of this form of ownership indicates the desirability of collecting statistics concerning their capitalization. While the capitalization of incorporated companies is not the true value of mining properties, nevertheless, the companies are in position to give the amount of capital stock and bonded indebtedness, and inquiries concerning such values can be answered readily. The census schedule, therefore, contained the following inquiries:

2. Capital stock, bonds, dividends, and assessments (if an incorporated company):

	BONDS.		PREFERRED STOCK.		COMMON STOCK.	
	Number.	Total par value.	Number of shares.	Total par value.	Number of shares.	Total par value.
Authorized..............	....	$.......	....	$.......	....	$.....
Issued to the end of the year..............	....	$.......	....	$.......	....	$.....

Dividends and interest, if any, paid during the year:

Common stock, rate..; amount, $........

Preferred stock, rate..; amount, $........

Bonds, rate..; amount, $........

Assessments: Total amount levied, if any, since organization of company.. $........

In the majority of cases the capitalization given in answer to this inquiry included values incident to the operation of all enterprises, industrial and commercial, carried on by the company reporting. For instance, if an iron company owned and operated a coal and an iron mine, the probabilities are that its total capitalization was reported, it being impossible to segregate the amount represented by each mining operation. It is probable that mining was the primary object of the formation of the majority of the companies, but in some cases mining was subservient to other interests, and, in a few instances, where the mining formed only a small proportion of the interests of the corporation, no capital stock was reported. The Pittsburg Plate Glass Company and the American Sewer Pipe Company are corporations of this character. The totals, therefore, can not be accepted as the capitalization of mining enterprises exclusively, nor can the dividends paid be accepted as the result of mining operations only.

Exclusive of those engaged in the production of natural gas and petroleum, there were 4,318 incorporated companies reported as engaged in the mining industries. Of this number, 4,045 answered the

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ing on the business. This statement, to be complete, should include as capital "all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return, or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890." The inquiry for the precious metals called for separate amounts, as follows: Total present actual cash value of mine and mining plant, $———, to be distributed as follows: Present actual cash value of buildings at mine, $———; present actual cash value of railroads on surface, $———; present actual cash value of machinery of all kinds above and below ground, including pumps, engines, boilers, cars, tools, etc., $———; present actual cash value of underground improvements, including shafts, tunnels, drifts, tramways, etc., $———; present actual cash value of mine supplies of all kinds on hand December 31, 1889, $———; present actual cash value of the mine itself, exclusive of the above items, $———; cash not reported in the foregoing items, $———; value of mill, smelting, or other reduction works, exclusive of mining property; present actual cash value of buildings, $———; present actual cash value of machinery and plant of all kinds except buildings, $———; present actual cash value of supplies on hand December 31, 1889, $———. In addition to these inquiries a circular letter issued to the enumerators on May 26, 1890, instructed them that the total actual value of the entire mining plant at the close of 1889 should be given without regard to the capitalization of the corporation or firm. If the land was owned in fee or in mineral rights, the number of acres attached to the collieries and under development, together with its actual value, should be stated. In the case of leased land, it should be practicable for the lessee to give the value per acre of the tract under development, and an effort should be made by the enumerator to obtain this data either from the lessee, lessor, or other reliable authority. If several collieries were drawing coal from the same bank, the value of the acreage for the same tract should be treated on one schedule and omitted from the others.

inquiries concerning capitalization. A large proportion of the production of petroleum in Pennsylvania, New York, Ohio, Indiana, and West Virginia, and also a considerable amount of the natural gas produced in these states, was covered in the report of the Standard Oil Company. In answering these inquiries this company gave an estimate of the capital stock and bonds it considered devoted to production, eliminating, as far as possible, the stock incident to the refining and to enterprises not directly connected with production of crude petroleum. The company also reported its inability to give the number of incorporated companies whose production of petroleum bought by it was included in its schedules; therefore the number of incorporated companies given in Table 26 for petroleum can not be accepted as the actual number engaged in its production. This table presents the statistics of capitalization for all incorporated companies for each mineral and group of minerals.

TABLE 26.—CAPITALIZATION OF INCORPORATED COM-

	MINERALS, BY GROUPS.	Number of incorporated companies.	Number of companies reporting.	Aggregate par value of stocks and bonds issued.	CAPITAL STOCK.		
					Total		
					Authorized.	Issued.	Dividends.
1	Total	5,386	4,878	$3,217,719,458	$3,440,194,087	$2,902,835,511	$72,416,913
2	Metallic	1,579	1,487	1,743,885,654	2,026,640,542	1,710,436,924	33,552,460
3	Copper ore	100	97	378,315,800	143,788,525	372,240,270	14,116,002
4	Gold and silver	1,079	1,020	1,024,970,648	1,215,120,117	1,017,011,793	10,454,714
5	Iron ore	214	183	247,798,950	265,053,900	233,933,470	6,829,415
6	Lead and zinc ore	159	162	51,426,801	59,423,300	45,923,641	2,500,015
7	Manganese ore	6	4	2,456,050	2,855,000	2,455,050	....
8	Quicksilver	21	21	39,017,700	14,100,000	38,872,700	171,994
9	Fuels	2,661	2,350	1,241,290,833	1,162,161,215	985,284,149	35,012,270
10	Coal, anthracite	76	69	142,032,212	70,749,350	55,482,490	4,975,459
11	Coal, bituminous	1,517	1,450	656,718,025	924,106,570	513,424,186	17,350,841
12	Natural gas	651	433	111,634,737	59,400,806	92,190,870	1,914,034
13	Petroleum	[1]417	[1]398	330,905,859	108,904,489	324,186,603	10,771,936
14	Structural materials	879	792	164,005,445	164,002,840	141,169,245	3,061,189
15	Cement	83	81	55,649,870	50,556,500	46,932,170	1,299,067
16	Clay	52	45	5,606,200	6,947,000	5,275,300	59,190
17	Limestones and dolomites	344	311	35,509,735	34,068,900	30,165,235	751,584
18	Marble	45	43	20,318,400	20,114,000	17,609,900	239,250
19	Sandstones and quartzites	119	104	16,219,850	14,551,600	13,821,750	276,956
20	Siliceous crystalline rocks	176	153	19,380,525	20,344,800	17,007,525	381,448
21	Slate	60	55	11,323,165	16,617,440	10,358,065	111,154
22	Abrasive materials	19	18	5,545,900	6,285,100	4,565,900	20,800
23	Corundum and emery	4	4	2,365,800	3,000,000	1,935,800	10,800
24	Crystalline quartz	2	2	300,000	500,000	300,000	10,000
25	Garnet	3	3	2,412,000	1,862,000	1,862,000	....
26	Grindstones and pulpstones	5	5	253,100	253,100	253,100	....
27	Infusorial earth, tripoli, and pumice	3	2	130,000	150,000	130,000	10,000
28	Oilstones, whetstones, and scythestones	2	2	85,000	50,000	85,000	....
29	Chemical materials	116	110	33,230,900	35,004,165	31,571,100	614,565
30	Borax	6	6	3,025,000	3,175,000	3,025,000	231,000
31	Fluorspar	14	14	2,214,000	3,813,000	2,164,000	....
32	Gypsum	26	25	10,670,965	10,776,665	10,525,965	64,500
33	Phosphate rock	56	53	13,775,935	13,290,500	12,321,135	316,265
34	Sulphur and pyrite	14	12	3,545,000	4,240,000	3,545,000	2,800
35	Pigments	28	25	2,105,600	12,382,300	1,861,100	14,079
36	Barytes	6	8	1,158,900	10,982,000	979,400	2,640
37	Mineral pigments, crude	22	17	946,700	1,400,300	881,700	11,439
38	Miscellaneous	104	96	28,692,726	33,617,725	27,246,626	141,550
39	Asbestos	3	3	2,010,000	2,300,000	2,010,000	....
40	Asphaltum and bituminous rock	19	17	9,760,700	10,575,000	9,760,700	13,000
41	Bauxite	5	3	118,000	225,000	118,000	....
42	Feldspar	8	7	298,100	424,000	298,100	8,500
43	Flint	3	3	195,000	210,000	195,000	....
44	Fuller's earth	3	2	250,000	250,000	250,000	....
45	Graphite	15	15	2,632,800	2,914,000	2,611,800	8,750
46	Marl	2	2	67,300	67,300	67,300	....
47	Mica	9	8	3,254,218	5,150,000	3,254,218	....
48	Monazite	1	1	1,000	500,000	1,000	....
49	Precious stones	10	10	1,562,078	2,120,000	1,562,078	20,000
50	Silica sand	10	9	595,275	635,000	554,175	....
51	Talc and soapstone	13	13	7,697,925	7,758,125	7,060,925	91,300
52	All other minerals[2]	3	3	200,000	300,000	200,000	....

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[1] The 28,925 operators reported by the Standard Oil Company are included as 1 incorporated company.
[2] Includes molybdenum, nickel and cobalt, and rutile.

PANIES, BY MINERALS AND GROUPS OF MINERALS: 1902.

CAPITAL STOCK—continued.						BONDS.			
Common.			Preferred.						
Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Interest.	
$3,226,237,630	$2,718,796,984	$63,610,969	$215,957,057	$184,038,560	$8,805,944	$361,069,615	$314,883,914	$13,603,924	1
1,928,126,652	1,626,075,027	29,572,132	100,513,690	84,361,897	4,000,028	52,156,700	33,448,130	1,337,203	2
420,321,625	361,388,770	13,667,012	12,466,500	10,851,500	448,990	6,950,000	6,073,530	174,500	3
1,194,317,427	1,002,055,586	10,124,711	19,102,690	14,956,197	380,033	9,839,200	7,958,850	409,392	4
204,052,400	182,651,625	3,183,440	61,001,500	51,281,845	3,145,965	22,647,500	13,865,500	521,111	5
56,380,200	43,551,296	2,446,475	3,043,000	2,372,355	53,540	12,575,000	5,405,250	226,200	6
2,255,000	1,855,050	....	600,000	600,000	....	....	....	....	7
50,800,000	34,572,700	150,494	4,300,000	4,300,000	21,500	145,000	145,000	6,000	8
1,080,072,388	910,864,461	30,869,484	82,088,827	74,419,688	4,142,786	273,836,645	255,106,684	11,243,708	9
58,589,350	54,692,390	1,933,242	1,160,000	790,100	3,208	87,925,222	86,649,722	3,790,145	10
518,756,263	443,749,259	13,297,525	75,350,207	69,674,927	4,062,305	153,493,556	142,293,839	6,115,828	11
98,565,806	91,385,870	4,894,134	835,000	805,000	49,900	20,642,867	19,443,867	1,040,402	12
404,160,969	321,036,942	10,744,583	4,743,620	3,149,661	27,373	11,775,000	6,719,256	297,333	13
141,145,800	125,098,570	2,576,609	22,917,040	16,070,675	454,680	28,359,400	22,839,200	909,507	14
42,003,000	38,653,520	958,367	8,533,500	8,278,650	251,300	9,578,400	8,717,700	316,962	15
6,272,600	4,637,300	55,690	675,000	628,000	3,500	436,000	331,000	18,110	16
30,597,400	27,554,775	681,353	4,074,500	2,610,460	70,181	6,206,500	5,344,500	258,362	17
16,741,000	14,151,900	139,250	3,670,000	3,458,000	100,000	4,475,000	2,708,500	93,290	18
14,526,600	13,800,750	275,732	25,000	20,600	1,224	2,586,000	2,398,500	98,485	19
19,848,300	16,650,325	383,438	478,500	357,000	....	3,752,000	2,373,500	89,873	20
11,156,900	9,650,100	82,679	5,460,540	707,965	28,475	1,325,500	965,500	34,425	21
5,685,100	4,309,900	20,000	550,000	256,000	10,860	1,070,000	980,000	24,000	22
3,100,000	1,729,800	....	500,000	206,000	10,860	470,000	430,000	24,000	23
300,000	300,000	10,000	....	....	....	....	....	....	24
1,862,000	1,862,000	....	....	....	....	600,000	550,000	....	25
203,100	203,100	....	50,000	50,000	....	....	....	....	26
130,000	130,000	10,000	....	....	....	....	....	....	27
90,000	85,000	....	....	....	....	....	....	....	28
27,986,665	24,678,600	477,415	7,107,500	6,892,500	137,090	2,980,800	1,659,800	64,450	29
2,925,000	2,775,000	231,600	250,000	250,000	....	....	....	....	30
3,813,000	2,154,000	....	....	....	....	100,000	60,000	....	31
6,046,665	5,995,965	64,300	4,530,000	4,530,000	....	1,145,000	145,000	2,700	32
11,292,000	10,343,635	179,115	1,977,500	1,977,500	137,090	1,735,800	1,454,800	61,750	33
3,910,000	3,410,000	2,400	350,000	135,000	....	....	....	....	34
12,293,300	1,781,300	12,879	90,000	80,300	1,200	1,765,000	241,000	8,850	35
10,983,000	979,900	2,640	....	....	....	1,700,000	176,000	6,000	36
1,310,300	801,400	10,239	90,000	80,300	1,200	65,000	65,000	2,850	37
30,927,725	25,989,126	82,550	2,690,000	1,957,500	59,300	901,100	706,100	16,206	38
2,000,000	1,875,000	....	300,000	135,000	....	....	....	....	39
10,575,000	9,760,701	13,000	....	....	....	110,000	....	....	40
225,000	148,000	....	....	....	....	....	....	....	41
424,000	298,600	8,800	....	....	....	....	....	....	42
200,000	185,000	....	10,000	10,000	....	....	....	....	43
130,000	130,000	....	100,000	100,000	....	....	....	....	44
2,664,000	2,384,800	8,750	250,000	230,000	....	20,000	18,000	1,040	45
67,300	67,300	....	....	....	....	....	....	....	46
5,450,000	3,254,248	....	....	....	....	....	....	....	47
500,000	1,000	....	....	....	....	....	....	....	48
2,129,000	1,562,078	20,000	....	....	....	....	....	....	49
635,000	554,175	....	....	....	....	41,100	41,100	2,466	50
5,728,425	5,568,425	32,000	2,030,000	1,482,500	59,300	730,000	647,000	12,600	51
200,000	200,000	....	....	....	....	....	....	....	52

Considering the total for the United States as shown by Table 26, it appears that of the 5,386 incorporated companies operating producing mines, 510 failed to answer the inquiry concerning capitalization. The data furnished by the 4,876 companies show that they were authorized to issue stock and bonds to the amount of $3,801,264,332. This total is composed of 1,234,500,357 shares of common and preferred stock, having a total par value of $3,440,194,687, and of bonds to the value of $361,069,645. The capital stock constituted 90.5 per cent of the total authorized capitalization and is composed of preferred stock to the value of $215,957,057 and common stock to the value of $3,224,237,630, the two forms of stock constituting 6.3 and 93.7 per cent, respectively, of the total. Of the total authorized capital stock, $2,902,835,544, or 84.4 per cent, had been issued and was outstanding at the end of the year. The par value of the common stock issued amounted to $2,718,796,984, or 84.3 per cent of such stock authorized, and the par value of the preferred stock issued amounted to $184,038,560, or 85.2 per cent of the total authorized. The par value of the bonds formed 9.5 per cent of the authorized capitalization and the par value of the bonds issued amounted to $314,883,914, or 9.8 per cent of the total capital stock and bonds issued.

Of the $72,416,913 reported as paid in dividends, $63,610,969 was paid on common stock and $8,805,944 on preferred stock, representing an average rate of 2.3 and 4.8 per cent, respectively, on all such stock issued. The interest paid on bonds amounted to $13,603,924, or 4.3 per cent on the par value of the $314,883,914 reported as issued. These percentages of dividends and interest are computed on the total amount of stock and bonds issued, irrespective of whether dividends or interest were paid by every particular corporation, and therefore the percentage of dividends is a total return on the total outstanding capitalization of the mining corporations.

Dividend paying companies.—Exclusive of natural gas and petroleum, 1,142 corporations reported the payment of dividends on common or preferred stock, or interest on bonds during the year, and the statistics for the capitalization of these companies are presented in Table 27 for each mineral.

TABLE 27.—CAPITALIZATION OF INCORPORATED COMPANIES PAYING EITHER

[Exclusive of natural

	MINERAL.	Number of companies paying dividends or interest.	AGGREGATE CAPITALIZATION.				CAPITAL STOCK.			
			Authorized.	Issued.	Dividends and interest.		Total.			
					Amount.	Rate per cent on total capital.	Authorized.	Issued.	Dividends.	
									Amount.	Rate per cent.
1	Total	1,142	$1,751,110,090	$1,524,662,218	$68,966,132	4.5	$1,454,850,275	$1,250,339,137	$56,700,943	4.5
2	Asphaltum and bituminous rock	2	300,000	300,000	13,000	4.3	300,000	300,000	13,000	4.3
3	Barytes	2	258,000	237,000	8,640	3.6	58,000	58,000	2,640	4.6
4	Borax	2	2,250,000	2,150,000	231,600	10.8	2,250,000	2,150,000	231,600	10.8
5	Cement	50	41,456,900	41,105,670	1,525,629	3.7	37,635,500	35,023,970	1,209,667	3.5
6	Clay	12	2,382,000	1,924,000	77,300	4.0	2,051,000	1,593,000	59,190	3.7
7	Coal, anthracite	36	136,658,822	133,219,772	5,725,604	4.3	50,737,400	48,673,850	1,936,459	4.0
8	Coal, bituminous	513	570,208,796	516,833,904	23,475,619	4.5	431,385,600	387,512,425	17,350,841	4.5
9	Copper ore	22	334,783,125	281,226,457	14,290,502	5.1	327,988,125	275,225,927	14,116,002	5.1
10	Corundum and emery	1	3,400,000	1,745,800	34,860	2.0	3,000,000	1,385,800	10,860	0.8
11	Crystalline quartz	1	250,000	250,000	10,000	4.0	250,000	250,000	10,000	4.0
12	Feldspar	2	198,000	148,000	8,800	5.9	198,000	148,000	8,800	5.9
13	Gold and silver	152	292,637,750	242,100,185	10,864,136	4.5	292,737,750	235,621,135	10,454,714	4.4
14	Graphite	2	95,000	93,000	9,880	10.6	75,000	75,000	8,750	11.7
15	Gypsum	8	750,000	744,000	67,000	9.0	705,000	699,000	64,300	9.2
16	Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	10.0	100,000	100,000	10,000	10.0
17	Iron ore	52	203,125,900	176,511,570	6,850,516	3.9	182,142,800	164,474,570	6,329,405	3.8
18	Lead and zinc ore	49	48,222,100	34,128,550	2,726,218	8.0	36,707,100	28,856,650	2,500,015	8.7
19	Limestones and dolomites	99	23,878,100	20,677,135	1,009,856	4.9	18,708,700	15,934,655	751,591	4.7
20	Marble	10	13,900,100	10,632,600	332,540	3.1	10,495,100	8,906,100	239,250	2.7
21	Mineral pigments, crude	5	446,300	436,600	14,289	3.3	391,300	381,600	11,439	3.0
22	Phosphate rock	22	9,709,800	9,326,900	377,935	4.1	8,325,000	8,197,500	316,205	3.9
23	Precious stones	1	100,000	100,000	20,000	20.0	100,000	100,000	20,000	20.0
24	Quicksilver	7	19,545,000	19,035,500	177,991	0.9	19,100,000	18,890,500	171,991	0.9
25	Sandstones and quartzites	25	11,185,000	11,079,400	575,411	5.2	8,920,000	8,695,900	256,956	3.0
26	Siliceous crystalline rocks	43	18,009,000	10,067,800	475,311	4.7	9,872,000	7,919,300	383,458	4.8
27	Silica sand	1	151,100	117,976	2,466	2.1	50,000	76,875	....	....
28	Slate	16	4,576,800	3,602,500	145,579	4.0	3,251,300	2,937,000	111,154	3.8
29	Sulphur and pyrite	1	60,000	60,000	2,400	4.0	60,000	60,000	2,400	4.0
30	Talc and soapstone	5	7,400,000	6,708,500	103,900	1.5	6,700,000	6,091,500	91,500	1.5

DIVIDENDS ON STOCK OR INTEREST ON BONDS, BY MINERALS: 1902.

gas and petroleum.]

CAPITAL STOCK—continued.								BONDS.				
Common.				Preferred				Authorized.	Issued.	Interest.		
Authorized	Issued.	Dividends.		Authorized.	Issued.	Dividends				Amount.	Rate per cent.	
		Amount.	Rate per cent.			Amount.	Rate per cent.					
$1,296,510,908	$1,109,335,128	$47,972,272	4.3	$168,328,367	$151,003,709	$8,728,671	5.8	$286,277,418	$264,323,091	$12,265,189	4.6	1
300,000	300,000	13,000	4.3	....	....	....	....	....	....	....	....	2
58,000	58,000	2,640	4.6	....	....	....	....	200,000	179,000	6,000	3.4	3
2,250,000	2,150,000	231,600	10.8	....	....	....	....	....	....	....	....	4
32,157,000	29,750,320	958,367	3.2	5,178,500	5,273,650	251,300	4.8	6,821,400	6,091,700	316,962	5.2	5
1,901,000	1,443,000	56,690	3.9	150,000	150,000	3,500	2.3	331,000	331,000	18,110	5.5	6
50,077,400	48,033,750	1,933,251	4.0	660,000	640,100	3,208	0.5	85,921,422	84,545,922	3,789,145	4.5	7
363,505,533	324,323,778	13,297,596	4.1	67,890,067	63,188,647	4,062,305	6.4	138,813,196	129,321,479	6,115,828	4.7	8
317,016,625	264,671,427	13,667,012	5.2	10,966,500	10,551,500	148,990	1.3	6,800,000	6,000,580	174,500	2.9	9
2,500,000	1,179,800	....	....	500,000	206,000	10,960	5.3	400,000	360,000	24,000	6.7	10
250,000	250,000	10,000	4.0	....	....	....	....	....	....	....	....	11
198,000	148,000	8,800	5.9	....	....	....	....	....	....	....	....	12
285,116,950	228,067,703	10,124,711	4.4	7,620,800	7,563,432	330,033	4.4	6,900,000	6,479,050	409,892	6.3	13
75,000	75,000	8,750	11.7	....	....	....	....	20,000	18,000	1,080	6.0	14
705,000	699,000	64,300	9.2	....	....	....	....	45,000	45,000	2,700	6.0	15
100,000	100,000	10,000	10.0	....	....	....	....	....	....	....	....	16
123,949,800	115,786,200	3,183,440	2.8	58,423,000	48,878,370	3,145,965	6.4	20,082,500	12,037,000	521,111	4.3	17
34,407,000	27,208,400	2,446,475	9.0	2,500,000	1,650,150	53,540	3.2	11,515,000	5,270,000	226,200	4.3	18
15,506,500	13,692,675	681,358	5.0	3,002,000	2,241,960	70,191	3.1	5,309,500	4,742,500	258,362	5.4	19
7,995,000	6,405,100	139,270	2.2	2,500,000	2,500,000	100,000	4.0	3,405,000	1,727,500	93,290	5.4	20
851,300	351,300	10,239	2.9	40,000	30,300	1,200	4.0	55,000	55,000	2,850	5.2	21
6,362,500	6,235,000	179,115	2.9	1,962,500	1,962,500	137,090	7.0	1,284,800	1,128,800	61,750	5.5	22
100,000	100,000	20,000	20.0	....	....	....	....	....	....	....	....	23
15,100,000	14,590,500	150,194	1.0	4,500,000	4,300,000	21,500	0.5	145,000	145,000	6,000	4.1	24
8,895,000	8,675,900	275,732	3.2	25,000	20,600	1,224	5.9	2,565,000	2,383,500	98,485	4.1	25
9,872,000	7,919,300	383,438	4.8	....	....	....	....	3,137,000	2,148,500	89,873	4.2	26
90,000	76,875	....	....	....	....	....	....	41,100	41,100	2,466	6.0	27
2,911,300	2,563,000	82,079	3.2	440,000	374,000	28,475	7.6	1,025,500	665,500	34,425	5.2	28
60,000	60,000	2,400	4.0	....	....	....	....	....	....	....	....	29
4,700,000	4,600,000	32,000	0.7	2,000,000	1,482,500	59,300	4.0	700,000	617,000	12,600	2.1	30

The par value of the authorized capital stock and bonds of the 1,142 companies paying either dividends or interest on all or part of their capitalization amounted to $1,751,116,693, or 46.1 per cent of the total authorized capitalization of all companies reported. The par value of the capital stock and bonds issued by these companies amounted to $1,524,662,218, or 47.4 per cent of the total amount issued by all companies. The capital stock and bonds actually issued by companies paying either dividends or interest formed 87.1 per cent of their total authorized capitalization, and the dividends and interest paid by them represented a return of 4.5 per cent on capital stock and bonds actually issued.

Table 28 shows the amount and kind of capital stock of all companies paying dividends on common or preferred stock.

TABLE 28.—CAPITAL STOCK OF INCORPORATED COMPANIES PAYING DIVIDENDS ON COMMON OR PREFERRED STOCK, BY MINERALS: 1902.

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of incorporated companies	TOTAL.			COMMON STOCK.			PREFERRED STOCK.		
		Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.
Total	919	$1,218,990,475	$1,045,760,265	$56,700,943	$1,061,491,108	$904,867,965	$47,972,272	$157,499,367	$140,892,300	$8,728,671
Asphaltum and bituminous rock	2	300,000	300,000	13,000	300,000	300,000	13,000			
Barytes	2	58,000	58,000	2,640	58,000	58,000	2,640			
Borax	2	2,250,000	2,150,000	231,600	2,250,000	2,150,000	231,600			
Cement	32	25,815,500	24,374,300	1,209,667	22,037,000	20,769,300	958,367	3,778,500	3,605,000	251,300
Clay	8	601,000	378,000	59,180	551,000	328,000	55,680	50,000	50,000	3,500
Coal, anthracite	20	26,170,400	25,759,150	1,936,479	26,110,400	25,719,050	1,933,251	60,000	40,100	3,228
Coal, bituminous	409	322,969,000	285,454,508	17,359,811	258,207,533	224,916,620	13,297,776	64,761,467	60,537,888	4,062,035
Copper ore	30	320,483,125	269,350,927	14,116,002	309,516,625	258,799,427	13,697,012	10,966,500	10,551,500	418,990
Corundum and emery	1	3,000,000	1,385,800	10,800	2,500,000	1,179,800		500,000	206,000	10,800
Crystalline quartz	1	250,000	250,000	10,000	250,000	250,000	10,000			
Feldspar	2	198,000	148,000	8,800	198,000	148,000	8,800			
Gold and silver	155	243,187,750	191,020,385	10,451,744	237,716,950	185,616,953	10,121,711	5,470,800	5,403,432	330,033
Graphite	2	75,000	75,000	8,750	75,000	75,000	8,750			
Gypsum	6	620,000	620,000	61,300	620,000	620,000	61,300			
Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	100,000	100,000	10,000			
Iron ore	43	173,730,300	157,487,070	6,329,405	116,762,300	110,133,700	3,183,440	56,968,000	47,353,370	3,145,965
Lead and zinc ore	49	36,707,000	28,858,550	2,500,015	34,407,000	27,208,400	2,446,475	2,300,000	1,650,150	53,540
Limestones and dolomites	86	12,389,200	10,908,335	751,534	10,412,200	9,491,375	681,353	1,977,000	1,416,960	70,181
Marble	5	6,345,000	6,305,000	239,250	4,345,000	4,305,000	139,250	2,000,000	2,000,000	100,000
Mineral pigments, crude	4	341,300	331,600	11,439	301,300	301,300	10,239	40,000	30,300	1,200
Phosphate rock	14	5,115,000	4,987,500	316,205	3,212,500	3,085,000	179,115	1,902,500	1,902,500	137,090
Precious stones	1	100,000	100,000	20,000	100,000	100,000	20,000			
Quicksilver	7	19,400,000	18,880,400	171,994	15,100,000	14,580,400	150,494	4,300,000	4,300,000	21,500
Sandstones and quartzites	20	5,045,000	4,842,800	276,956	5,020,000	4,822,800	275,732	25,000	20,000	1,224
Siliceous crystalline rocks	34	6,472,000	5,074,900	383,458	6,472,000	5,074,900	383,458			
Slate	9	1,911,300	1,797,800	111,154	1,511,300	1,455,800	82,679	400,000	342,000	28,475
Sulphur and pyrite	1	60,000	60,000	2,400	60,000	60,000	2,400			
Talc and soapstone	3	5,300,000	4,591,500	91,300	3,200,000	3,209,000	32,000	2,100,000	1,382,500	59,300

There were 919 companies that reported the payment of dividends on either common or preferred stock. The par value of the authorized capital stock of these companies amounted to $1,218,990,475, or 35.4 per cent of the total authorized capital stock of all companies, and the par value of the stock issued amounted to $1,045,760,265, or 36.0 per cent of the total capital stock issued by all companies. The dividends which were paid on either or both of these classes of stocks amounted to $56,700,943, or a return of 5.4 per cent on the stock issued by such companies.

Common stock.—Exclusive of the companies engaged in the production of natural gas and petroleum there were 3,724 companies authorized to issue common stock to the amount of $2,721,510,955. Of this number 3,686 companies had actually issued common stock to the par value of $2,306,374,172. As shown by Table 27 the par value of the authorized common stock of companies paying either dividends on one or the other class of stock or interest on bonds amounted to $1,286,510,908, and the par value of the common stock issued by these companies amounted to $1,109,335,428; the dividends paid amounted to $47,972,272, a return of 4.3 per cent on the common stock issued. These amounts include common stock on which no dividends were paid, but which was issued by companies paying dividends on preferred stock or interest on bonds. There were 837 companies that reported the payment of dividends on common stock and the statistics for the common stock of these companies are summarized in Table 29.

TABLE 29.—*Common stock of incorporated companies paying dividends on such stock: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of companies.	COMMON STOCK.		DIVIDENDS.	
		Authorized.	Issued.	Amount.	Rate per cent.
Total	837	$901,434,650	$687,810,418	$47,972,272	7.0
Asphaltum and bituminous rock	2	300,000	300,000	13,000	4.3
Barytes	2	58,000	58,000	2,640	4.6
Borax	2	2,250,000	2,150,000	231,600	10.8
Cement	26	12,567,000	11,441,910	958,367	8.4
Clay	7	501,000	278,000	55,630	20.0
Coal, anthracite	19	25,860,400	25,469,050	1,933,251	7.6
Coal, bituminous	382	184,063,200	153,584,420	13,297,536	8.7
Copper ore	15	230,150,000	210,834,340	13,667,012	6.5
Crystalline quartz	1	250,000	250,000	10,000	4.0
Feldspar	2	198,000	148,000	8,800	5.9
Gold and silver	132	235,316,950	183,466,983	10,124,711	5.5
Graphite	2	75,000	75,000	8,750	11.7
Gypsum	6	620,000	620,000	64,300	10.4
Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	10.0
Iron ore	30	44,975,300	44,834,300	3,183,140	7.1
Lead and zinc ore	41	27,957,000	20,758,400	2,446,175	11.8
Limestones and dolomites	81	8,328,200	7,808,775	681,353	8.7
Marble	5	4,315,000	4,305,000	139,250	3.2
Mineral pigments, crude	8	241,300	241,300	10,239	4.2
Phosphate rock	9	1,410,000	1,282,500	179,115	14.0
Precious stones	1	100,000	100,000	20,000	20.0
Quicksilver	6	9,100,000	8,890,500	150,494	1.7
Sandstones and quartzites	19	4,995,000	4,840,300	278,782	5.7
Siliceous crystalline rocks	33	6,072,000	4,774,800	383,498	8.0
Slate	7	911,300	868,800	82,679	9.5
Sulphur and pyrite	1	60,000	60,000	2,400	4.0
Talc and soapstone	2	300,000	300,000	32,000	10.7

The 60 companies that paid dividends on preferred stock but no dividends on common stock had common stock issued to the value of $183,139,447, or 64.8 per cent of the total common and preferred stock issued by these companies. The dividends paid on the preferred stock of these companies amounted to $6,102,385, a return of 6.1 per cent on the par value of such stock issued.

The common stock issued and on which dividends were paid amounted to $687,810,418, or only 29.8 per cent of the total amount of common stock issued by all companies. The dividends paid on this stock amounted to $47,972,272, or a return of 7 per cent. Of the 3,686 companies reporting the issue of common stock there were 2,849 that paid no dividends on such stock. The par value of the authorized common stock of these companies amounted to $1,920,076,305, or 70.6 per cent of the total for all companies, and the amount issued was valued at $1,618,563,754, or 70.2 per cent of the total amount issued. In addition 60 companies that reported the issue of common stock paid dividends on preferred stock but no dividends on common stock, and the statistics for these companies are summarized in the following table:

TABLE 30.—CAPITALIZATION OF INCORPORATED COMPANIES PAYING DIVIDENDS ON PREFERRED STOCK BUT NOT ON COMMON STOCK: 1902.

MINERAL.	Number of companies.	AGGREGATE CAPITALIZATION.		CAPITAL STOCK.			
				Total.		Common.	
		Authorized.	Issued.	Authorized.	Issued.	Authorized.	Issued.
Total	60	$369,447,292	$314,377,787	$334,504,125	$282,624,287	$224,660,458	$183,139,447
Cement	6	13,880,000	13,385,450	12,820,000	12,532,450	9,470,000	9,327,450
Clay	1	100,000	100,000	100,000	100,000	50,000	50,000
Coal, anthracite	1	485,000	386,100	310,000	290,100	250,000	250,000
Coal, bituminous	19	151,917,667	142,722,103	124,550,000	117,621,103	74,114,333	70,061,200
Copper ore	4	88,333,125	56,516,597	88,333,125	56,516,597	77,366,625	45,965,097
Corundum and emery	1	3,400,000	1,745,800	3,000,000	1,385,800	2,500,000	1,179,800
Gold and silver	3	3,800,000	3,532,007	3,800,000	3,532,007	2,400,000	2,150,000
Iron ore	11	78,595,500	68,750,670	73,708,000	64,403,170	41,741,000	37,902,300
Lead and zinc ore	1	5,100,000	5,024,600	5,100,000	5,024,600	3,800,000	3,800,000
Limestones and dolomites	5	4,681,000	3,765,560	3,628,000	2,769,560	2,081,000	1,682,600
Mineral pigments, crude	1	100,000	90,300	100,000	90,300	60,000	60,000
Phosphate rock	2	3,005,000	3,005,000	3,005,000	3,005,000	1,502,500	1,502,500
Quicksilver	1	10,000,000	10,000,000	10,000,000	10,000,000	5,700,000	5,700,000
Sandstones and quartzites	1	50,000	33,100	50,000	33,100	25,000	12,500
Slate	2	1,000,000	929,000	1,000,000	929,000	600,000	587,000
Talc and soapstone	1	5,000,000	4,391,500	5,000,000	4,391,500	3,000,000	2,909,000

MINERAL.	CAPITAL STOCK.				BONDS.			
	Preferred.							
			Dividends.				Interest.	
	Authorized.	Issued.	Amount.	Rate per cent.	Authorized.	Issued.	Amount.	Rate per cent.
Total	$109,843,667	$99,484,840	$6,102,385	6.1	$34,943,167	$31,753,500	$1,826,648	5.8
Cement	3,350,000	3,205,000	227,310	7.1	1,060,000	853,000	39,856	4.7
Clay	50,000	50,000	3,500	7.0				
Coal, anthracite	60,000	40,100	3,208	8.0	175,000	96,000	5,835	6.1
Coal, bituminous	50,435,667	47,559,903	3,325,650	7.0	27,367,667	25,101,000	1,451,194	5.8
Copper ore	10,966,500	10,551,500	448,990	4.3				
Corundum and emery	500,000	206,000	10,800	5.8	400,000	360,000	24,000	6.7
Gold and silver	1,400,000	1,382,007	90,640	6.6				
Iron ore	31,967,000	26,500,870	1,720,942	6.5	4,887,500	4,347,500	255,941	5.9
Lead and zinc ore	1,300,000	1,224,600	19,496	1.6				
Limestones and dolomites	1,547,000	1,086,960	49,881	4.6	1,053,000	996,000	49,822	5.0
Mineral pigments, crude	40,000	30,300	1,200	4.0				
Phosphate rock	1,502,500	1,502,500	90,200	6.0				
Quicksilver	4,300,000	4,300,000	21,500	0.5				
Sandstones and quartzites	25,000	20,600	1,224	5.9				
Slate	400,000	342,000	28,475	8.3				
Talc and soapstone	2,000,000	1,482,500	59,300	4.0				

Preferred stock.—Exclusive of natural gas and petroleum, there were 244 companies authorized to issue preferred stock to the value of $210,378,437. Of this number 234 companies had actually issued preferred stock to the value of $180,083,899. As shown by Table 27, the par value of the authorized preferred stock of companies paying either dividends on one class of stock or interest on bonds amounted to $168,328,367, and the par value of the preferred stock issued by these companies amounted to $151,003,709. The dividends paid amounted to $8,728,671, or a return of 5.8 per cent on the preferred stock issued. These amounts include preferred stock on which no dividends were paid but which was issued by companies paying dividends on common stock or interest on bonds. There were 87 companies that reported the payment of dividends on preferred stock, and the statistics for the preferred stock of these companies are summarized in the following table:

TABLE 31.—*Preferred stock of incorporated companies paying dividends on such stock, by minerals: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of companies paying dividends.	PREFERRED STOCK.		DIVIDENDS.	
		Authorized.	Issued.	Amount.	Rate per cent.
Total	87	$157,450,867	$140,892,300	$8,728,671	6.2
Cement	7	3,730,000	3,605,000	251,300	7.0
Clay	1	50,000	50,000	3,500	7.0
Coal, anthracite	1	60,000	40,100	3,208	8.0
Coal, bituminous	31	64,761,067	60,537,888	4,062,505	6.7
Copper ore	4	10,966,500	10,551,500	448,950	4.3
Corundum and emery	1	500,000	200,000	10,600	5.3
Gold and silver	5	5,470,800	5,403,432	330,053	6.1
Iron ore	13	56,968,000	47,353,970	3,115,565	6.6
Lead and zinc ore	5	2,300,000	1,650,150	53,540	3.2
Limestones and dolomites	8	1,977,000	1,416,900	70,181	5.0
Marble	1	2,000,000	2,000,000	100,000	5.0
Mineral pigments, crude	1	40,000	30,300	1,200	4.0
Phosphate rock	4	1,902,500	1,902,500	137,050	7.2
Quicksilver	1	4,300,000	4,300,000	21,500	0.5
Sandstones and quartzites	1	25,000	20,600	1,221	5.9
Slate	2	400,000	342,000	28,475	8.3
Talc and soapstone	1	2,000,000	1,482,500	59,300	4.0

The preferred stock on which dividends were paid amounted to $140,892,300, or 78.2 per cent of the total amount of preferred stock issued by all companies. The dividends paid on this stock amounted to $8,728,671, a return of 6.2 per cent on the amount issued. Of the 234 companies reporting the issue of preferred stock, there were 147 that paid no dividends on such stock. The par value of the authorized preferred stock of these companies was $52,927,570, or 25.3 per cent of the total for all companies, and the amount issued $39,191,599, or 21.8 per cent.

Bonds.—The $288,720,791 shown as the par value of the bonds issued includes all bonds issued by all companies irrespective of the payment of interest or dividends. The following table presents the statistics for the 363 companies that paid interest on bonds:

TABLE 32.—*Bonds of incorporated companies paying interest on bonds, by minerals: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of incorporated companies.	Bonds authorized.	Bonds issued.	INTEREST.	
				Amount.	Rate per cent.
Total	363	$281,115,418	$257,233,551	$12,265,189	4.8
Barytes	1	200,000	179,000	6,000	3.4
Cement	25	6,821,400	6,081,700	316,962	5.2
Clay	4	331,000	331,000	18,110	5.5
Coal, anthracite	20	85,921,422	84,545,922	3,789,145	4.5
Coal, bituminous	179	136,028,196	127,345,679	6,115,828	4.8
Copper ore	4	3,800,000	3,001,000	174,500	5.8
Corundum and emery	1	400,000	360,000	24,000	6.7
Gold and silver	21	6,900,000	6,479,050	409,392	6.3
Graphite	1	20,000	18,000	1,080	6.0
Gypsum	2	45,000	45,000	2,700	6.0
Iron ore	22	10,637,500	9,923,000	521,111	5.3
Lead and zinc ore	7	11,515,000	5,270,000	225,200	4.3
Limestones and dolomites	25	5,269,500	4,762,500	258,302	5.4
Marble	7	3,405,000	1,727,500	93,290	5.4
Mineral pigments, crude	2	55,000	55,000	2,850	5.2
Phosphate rock	11	1,384,800	1,128,800	61,770	5.5
Quicksilver	1	145,000	145,000	6,000	4.1
Sandstones and quartzites	6	2,565,000	2,383,500	98,485	4.1
Siliceous crystalline rocks	13	5,137,000	2,148,500	89,873	4.2
Silica sand	1	41,100	41,100	2,466	6.0
Slate	8	1,025,700	665,500	34,425	5.2
Talc and soapstone	2	700,000	617,000	12,660	2.1

The bonds issued on which interest was paid amounted to $257,233,551, or 89.1 per cent of the total amount of bonds issued by all companies. The interest paid on these bonds amounted to $12,265,189, or a return of 4.8 per cent on the amount issued. The 363 companies that reported the payment of interest on bonds were authorized to issue bonds to the value of $281,115,418. The amount actually issued and on which interest was paid formed 91.5 per cent of the total authorized bonded debt.

Natural gas and petroleum.—As explained on page 76, the capitalization reported for natural gas and petroleum should be considered separately from that of other minerals. Table 33 shows that the total authorized capitalization of the companies engaged in the production of these substances amounted to $540,723,162, of which $442,540,596 had been issued. This includes the capitalization reported by the Standard Oil Company. A total of $17,054,705 is reported as having been paid in dividends and interest on bonds, representing a return of 3.8 per cent on the capitalization (stock and bonds) issued. In Table 33 the capitalization shown as issued includes all stock and bonds irrespective of the payment of dividends and interest.

TABLE 33.—*Capitalization of incorporated companies producing natural gas and petroleum and reporting capitalization: 1902.*

	Total.	Natural gas.	Petroleum.
Number of companies reporting	831	433	[1] 398
Total capital stock and bonds:			
Authorized	$540,723,162	$120,043,673	$420,679,489
Issued	442,540,596	111,634,737	330,905,859
Dividends and interest	17,054,705	5,985,436	11,069,269
Capital stock—			
Total authorized	508,305,295	99,400,806	408,904,489
Total issued	416,377,473	92,190,870	324,186,603
Total dividends paid	15,715,970	4,944,034	10,771,936
Common—			
Authorized	502,726,675	96,565,806	406,160,869
Issued	412,422,812	91,385,870	321,036,942
Dividends paid	15,638,697	4,894,134	10,744,563
Preferred—			
Authorized	5,578,620	835,000	4,743,620
Issued	3,954,661	805,000	3,149,661
Dividends paid	77,273	49,900	27,373
Bonds—			
Authorized	32,417,867	20,642,867	11,775,000
Issued	26,163,123	19,443,867	6,719,256
Interest	1,338,735	1,041,402	297,333

[1] The 28,925 producers reported by the Standard Oil Company are included as 1 incorporated company.

Considering the report of the Standard Oil Company as representing a single producer for natural gas and for petroleum, the following table shows the number of operators and the capitalization of the companies reporting the payment of dividends on either common or preferred stock or interest on bonds:

TABLE 34.—*Capitalization of natural gas and petroleum companies paying dividends or interest on bonds: 1902.*

	Total.	Natural gas.	Petroleum.
Number of companies reporting dividends or interest	248	164	84
Total capital stock and bonds:			
Authorized	$323,419,247	$98,013,747	$225,405,500
Issued	$281,335,689	$94,272,929	$187,062,760
Capital stock—			
Authorized	$292,728,380	$78,072,880	$214,655,500
Issued	$256,612,860	$75,446,062	$181,166,798
Common—			
Authorized	$289,528,380	$77,272,880	$212,255,500
Issued	$253,726,423	$74,676,062	$179,050,361
Dividends paid	$15,638,697	$4,894,134	$10,744,563
Rate per cent	6.2	6.6	6.0
Preferred—			
Authorized	$3,200,000	$800,000	$2,400,000
Issued	$2,886,437	$770,000	$2,116,437
Dividends paid	$77,273	$49,900	$27,373
Rate per cent	2.7	6.5	1.3
Bonds—			
Authorized	$30,690,867	$19,940,867	$10,750,000
Issued	$24,722,829	$18,826,867	$5,895,962
Interest paid	$1,338,735	$1,041,402	$297,333
Rate per cent	5.4	5.5	5.0

The par value of the authorized capital stock and bonds of the 248 companies paying either dividends or interest on all or part of their capitalization amounted to $323,419,247, or 59.8 per cent of the total authorized capitalization of all companies reported as engaged in the production of natural gas and petroleum. The par value of the capital stock and bonds issued by these companies amounted to $281,335,689, or 63.6 per cent of the total amount issued. The capitalization actually issued by companies paying either dividends or interest formed 87 per cent of their total authorized capitalization, and the dividends and interest paid by them represented a return of 6.1 per cent on capital stock and bonds actually issued.

Of the 248 companies there were 216 that reported the payment of dividends on either common or preferred stock. The par value of the authorized capital stock of these companies amounted to $225,767,930, or 41.8 per cent of the total authorized capital stock of all companies; and the par value of the stock issued amounted to $211,774,741, or 47.9 per cent of the total capital stock issued by all companies. The dividends that were paid on either or both of these classes of stock amounted to $15,715,970, or a return of 7.4 per cent on the stock issued by such companies.

Capitalization of incorporated companies, by states and territories.—As previously explained, the capital stock of incorporated companies represented their entire capitalization. In some cases the companies operated mines in different states and were engaged in the production of different minerals. For instance, a mining company engaged primarily in the production of iron ore may also operate a limestone quarry, and some of its enterprises may be located in different states. It was impracticable to segregate the capital stock so as to show the amount devoted to each industry in each state, therefore the total capitalization was assigned to the mineral or state representing the interest of greatest value. With the exception of buhrstones and millstones, lithium ore, tungsten, and uranium and vanadium, the production of all of the minerals for which separate statistics are shown was controlled to some extent by the corporate form of organization and incorporated companies were reported for every state and territory in which minerals were mined. Statistics concerning employees, wages, expenses, and production of incorporated companies are given in Table 23, page 68, but since in an unknown number of instances the capital stock represented interests other than mining and since the capitalization for some companies was not reported or, for the reasons explained above, was excluded from the statistics, a satisfactory comparison of capitalization and production is impracticable. The statistics for the capitalization for all minerals in each state and territory are presented in Table 35.

TABLE 35.—CAPITALIZATION OF INCORPORATED

	STATE OR TERRITORY.	Number of incorporated companies.	Number reporting.	AGGREGATE CAPITALIZATION.			CAPITAL STOCK.		
							Total.		
				Authorized.	Issued.	Interest and dividends.	Authorized.	Issued.	Dividends.
1	United States	5,386	4,876	$3,801,264,332	$3,217,719,158	$86,020,837	$3,440,194,687	$2,902,835,544	$72,436,913
2	Alabama	111	105	92,613,200	78,146,800	2,080,000	70,689,700	58,723,300	979,588
3	Alaska	1	1	2,004,000	1,780,000	14,250	1,504,000	1,504,000	....
4	Arizona	67	66	88,795,000	70,308,622	4,150,296	84,360,000	66,186,092	4,071,586
5	Arkansas	33	32	21,196,800	14,921,750	328,109	19,206,800	13,022,750	328,109
6	California	512	484	438,557,414	335,109,463	4,180,120	431,327,414	331,682,113	3,008,375
7	Colorado	484	457	567,847,417	496,634,083	6,298,171	538,099,917	468,130,083	5,002,712
8	Connecticut	19	18	4,467,000	3,851,900	92,195	3,797,000	3,181,900	64,095
9	Delaware	7	7	1,776,000	1,296,000	16,360	1,770,000	1,290,000	16,000
10	Florida	28	21	6,504,800	6,217,800	179,840	5,318,000	5,197,000	121,380
11	Georgia	61	53	45,028,500	31,002,500	207,920	43,983,500	29,756,000	176,270
12	Hawaii	1	....	....	....	....	....	....	....
13	Idaho	77	72	85,788,400	67,712,257	925,771	82,954,200	66,878,357	881,771
14	Illinois	251	244	43,437,400	40,137,600	1,081,745	47,787,400	35,125,000	792,619
15	Indian Territory	27	27	10,139,000	6,056,500	1,650	9,389,000	5,474,500	1,650
16	Indiana	480	370	68,551,700	64,350,145	5,725,801	53,646,093	50,178,178	2,960,151
17	Iowa	101	98	9,024,500	7,680,310	184,767	8,136,500	6,987,310	167,187
18	Kansas	102	75	19,001,915	16,181,027	321,750	17,440,215	11,578,327	272,951
19	Kentucky	176	166	47,895,000	37,327,446	529,025	45,570,900	35,302,984	148,752
20	Louisiana	3	3	990,000	521,000	....	900,000	520,000	....
21	Maine	32	28	9,339,500	8,506,100	160,422	6,242,000	5,458,100	31,177
22	Maryland	70	48	27,456,800	24,072,750	800,225	22,821,800	19,963,750	570,065
23	Massachusetts	37	37	13,876,000	9,801,450	263,583	10,790,000	8,137,950	212,400
24	Michigan	114	100	182,704,000	163,075,845	6,851,177	168,969,000	158,311,045	6,763,801
25	Minnesota	41	36	65,340,000	57,195,300	1,758,009	65,315,000	57,169,300	1,738,009
26	Missouri	231	224	60,451,600	43,075,110	1,037,526	60,283,600	41,998,860	906,546
27	Montana	94	92	392,474,000	329,892,950	7,000,209	388,785,000	327,228,960	6,894,069
28	Nebraska	3	3	65,000	65,000	2,250	65,000	65,000	2,250
29	Nevada	17	15	55,752,300	49,860,796	80,002	55,752,300	49,860,796	80,002
30	New Hampshire	13	13	769,500	668,450	1,100	769,500	668,450	1,100
31	New Jersey	19	12	33,724,100	25,180,770	2,138,151	22,886,000	21,843,250	1,945,934
32	New Mexico	62	57	64,617,000	41,103,491	189,120	62,932,000	39,193,491	111,110
33	New York	119	104	42,704,400	39,912,880	886,767	36,106,900	34,177,380	722,411
34	North Carolina	30	24	19,208,425	13,552,625	6,000	18,098,425	12,518,625	....
35	North Dakota	9	8	2,375,000	2,185,000	....	2,375,000	2,085,000	....
36	Ohio	321	278	117,090,500	109,767,280	7,600,582	101,980,500	97,476,780	1,297,103
37	Oklahoma	1	1	700,000	600,000	2,400	700,000	600,000	2,400
38	Oregon	58	51	44,516,800	29,437,421	65,269	44,516,800	29,437,421	65,269
39	Pennsylvania	596	518	490,581,302	461,959,660	21,689,856	344,742,703	320,001,628	15,629,567
40	Rhode Island	3	3	600,000	568,400	....	600,000	568,400	....
41	South Carolina	22	19	3,437,000	2,916,500	21,740	3,129,000	2,608,500	2,500
42	South Dakota	29	29	68,455,500	57,096,144	271,445	68,455,500	57,096,144	271,445
43	Tennessee	100	95	28,925,480	26,779,749	617,565	24,173,820	22,872,080	137,668
44	Texas	183	174	113,191,900	87,969,608	1,025,024	107,440,400	82,937,918	806,020
45	Utah	96	93	116,384,400	112,239,671	4,482,497	114,315,000	110,260,674	4,105,800
46	Vermont	27	26	12,443,100	10,090,300	274,514	9,955,900	8,744,800	239,584
47	Virginia	63	51	17,265,200	15,148,200	268,280	15,790,200	13,706,200	200,280
48	Washington	50	46	93,005,029	73,808,003	1,202,212	76,723,200	58,676,771	642,112
49	West Virginia	274	250	130,969,700	114,845,344	3,924,022	114,404,700	100,105,844	3,225,497
50	Wisconsin	67	59	14,588,000	13,802,575	401,020	13,928,000	13,307,575	375,250
51	Wyoming	21	17	16,567,000	12,800,000	151,400	16,467,000	12,700,000	140,000

COMPANIES, BY STATES AND TERRITORIES: 1902.

CAPITAL STOCK—continued.						BONDS.			
Common.			Preferred.						
Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Interest.	
$3,221,257,630	$2,718,796,984	$63,610,969	$215,957,057	$184,088,560	$8,805,941	$351,069,645	$311,889,914	$13,663,924	1
55,927,200	48,129,600	317,413	14,762,500	10,583,700	662,175	21,923,500	19,423,500	1,100,442	2
1,500,000	1,500,000		4,000	4,000		500,000	285,000	14,250	3
82,340,000	64,186,092	4,071,586	2,020,000	2,000,000		4,435,000	4,212,550	78,710	4
12,714,900	11,217,425	253,514	6,491,900	1,805,325	71,565	1,990,000	1,899,000		5
418,827,294	319,856,252	2,691,707	12,500,120	11,827,161	316,668	7,290,000	3,426,050	177,745	6
536,307,217	458,516,833	4,578,349	11,792,700	9,913,200	431,393	29,747,500	28,204,650	1,288,429	7
2,747,000	2,520,400	48,900	1,050,000	661,500	15,785	670,000	670,000	27,500	8
1,370,000	880,000	16,000	400,000	400,000		6,000	6,000	300	9
5,008,000	4,887,000	92,490	310,000	310,000	31,880	1,276,800	1,020,800	55,510	10
41,221,000	27,015,500	156,270	2,762,500	2,540,500		1,640,000	1,446,500	51,650	11
									12
79,154,200	65,029,857	891,771	3,500,000	1,848,500		834,200	833,900	44,000	13
36,654,100	34,103,600	796,459	1,133,000	1,022,000	13,160	5,650,000	5,012,000	282,126	14
9,339,000	5,474,500	1,620				800,000	582,000		15
53,237,093	49,770,478	2,955,911	409,000	408,000	21,240	14,905,667	14,160,667	716,650	16
5,966,520	4,808,240	168,137	2,179,980	2,179,070	1,050	888,000	643,000	17,580	17
17,559,215	14,468,327	272,951	110,000	110,000		1,552,700	1,552,700	48,840	18
45,580,800	35,322,964	447,532	40,000	40,000	1,200	2,324,200	1,961,162	80,891	19
760,000	720,000		200,000						20
5,185,000	4,551,100	26,177	1,107,000	907,000	5,000	3,097,500	3,048,000	138,215	21
20,686,800	17,645,750	439,045	2,155,000	1,948,000	131,970	4,685,000	4,479,000	229,340	22
10,200,000	7,931,950	191,600	640,000	206,000	10,840	3,098,000	1,663,500	60,923	23
138,749,000	132,269,045	6,297,818	30,180,000	26,042,000	1,465,968	13,765,000	4,704,800	67,376	24
40,275,000	36,277,800	318,026	25,040,000	20,882,000	1,424,983	25,000	25,000		25
61,370,600	38,356,505	918,006	3,913,000	3,242,355	53,540	4,118,000	1,476,250	70,980	26
382,484,000	321,172,580	6,744,069	6,300,000	6,004,400	150,000	3,600,000	2,669,000	172,200	27
65,000	65,000	2,250							28
55,302,400	49,500,796	32,002	450,000	300,000	48,000				29
709,500	668,450	1,100							30
20,056,600	18,040,650	1,886,210	2,850,000	2,802,600	79,724	10,887,500	4,837,500	172,500	31
62,252,000	38,798,491	74,410	700,000	700,000	40,000	1,686,000	1,610,000	75,000	32
29,626,900	28,245,050	645,111	6,480,000	5,932,500	77,300	6,597,500	5,765,000	161,356	33
17,994,425	12,408,625		105,000	105,000		1,110,000	1,039,000	6,000	34
2,475,000	2,095,000								35
99,911,500	96,022,280	6,561,028	2,078,000	1,454,500	36,070	15,101,000	12,290,500	485,419	36
760,000	660,000	2,400							37
44,516,800	29,437,421	65,269							38
290,349,496	269,687,590	12,442,037	54,393,207	51,013,048	3,187,830	145,858,689	141,359,022	6,059,989	39
600,000	568,400								40
2,864,000	2,373,500	2,500	265,000	235,000		308,000	308,000	19,240	41
67,555,500	56,214,137	254,803	900,000	882,007	17,640				42
22,046,600	20,599,485	319,215	2,427,160	2,272,601	114,458	4,521,000	3,887,600	178,297	43
105,050,400	81,903,914	781,896	2,850,000	1,029,000	24,195	6,051,000	5,036,694	218,934	44
114,205,500	110,260,674	4,403,800	48,500			2,069,400	1,978,400	78,687	45
7,366,000	6,730,300	139,584	2,026,500	2,014,500	100,000	3,050,000	1,345,500	34,970	46
14,515,200	12,531,200	209,280	1,275,000	1,175,000		1,475,000	1,442,000	59,000	47
67,580,210	51,130,684	385,862	9,142,990	7,546,030	256,250	16,281,829	15,131,829	560,100	48
113,059,700	98,760,844	3,215,497	1,345,000	1,345,000	10,000	16,565,000	14,729,500	698,525	49
13,643,000	13,017,575	375,250	290,000	290,000		655,000	565,000	25,750	50
16,467,000	12,700,000	149,000				100,000	100,000	5,400	51

VIII.

EMPLOYEES AND WAGES.[1]

The schedules used at the Twelfth Census for collecting statistics of employees and wages contained several important inquiries not used at previous censuses. Thus in 1902 employees were segregated into general groups of occupations, to show the prevailing daily rates of pay for each occupation and the average number employed during each month of the year; the number engaged in mining or quarrying who received pay according to the quantity of work done (namely, the number of tons, cars, or yards mined) and the total amount paid for such work; the amount paid for contract work, such as tunneling, sinking of shafts, boring test holes, etc., when done by independent contractors, and the number of men employed in such work; and, finally, the total number of days that the mines or quarries were in operation during the year.

No provision was made in the schedule for a separate report of female employees, either wage-earners or those receiving salaries. There is no doubt that among the salaried employees there were some female clerks, but so few as to be a negligible quantity and of no statistical importance, and none of them was engaged in the actual mining or quarrying. On the other hand the number of females engaged in the different branches of manufacturing is comparatively large and, therefore, of vital economic and sociologic importance.

In the various tables in this report showing wage-earners and wages comparisons have been made with the statistics of earlier censuses whenever they were available; but because of the adoption of a radically different method of ascertaining the average number of wage-earners at this census any comparisons will be invalidated to a considerable degree. In the schedules for 1889 the inquiry as to the number of persons employed asked for the number of foremen or overseers separately, but the inquiry as to the amount of wages paid did not call for a separate statement as to the amount paid in wages to this class of employees. As a result, the statistics for labor and wages published in the Report on Mineral Industries at the Eleventh Census show separately the number of foremen and overseers, but not the amounts received by them, and in no case can the wages paid to this class of employees be separated. In the statistics for 1902, on the other hand, foremen and overseers, with their salaries, are included with superintendents, managers, surveyors, etc., and not with wage-earners.

Again, the schedule for 1889 called for a separate statement as to the amount paid for contract work, but not for the number of persons employed on such work, though such employees were probably included in the total average number of wage-earners.

In the schedule for 1889 the inquiry as to labor and wages is followed by this note: "In giving the number of men employed include those employed by contractors and subcontractors as well as by the company itself." In the corresponding inquiry of the schedule for 1902 the note of instruction reads as follows: "Amounts paid for contract work not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but should be reported in answer to inquiry 6." In inquiry 6 of the schedule for 1902 the amount paid for tunneling, shaft sinking, boring test holes, etc., if not done by employees hired directly, and the average number of men employed on such work are asked for separately.

The greatest difference, however, between the statistics for the two censuses results from a radical change in the method of obtaining the average number of persons employed. In editing the schedules for 1902 the figures for the average number of employees were reduced to a 300-day basis whenever the schedule showed them to be the average number for a shorter period; when it was evident that the employees had worked more than 300 days, the average number for the longer period was allowed to stand. The figures for 1902, therefore, show the average number of employees that would be required at continuous employment throughout the year to perform the work done, while the figures for 1889 represent the average number employed during the actual time that the several establishments concerned were in operation and not an average number for the whole year.[2]

It is obvious that the method adopted in 1902 tends to produce a smaller average number than the method employed in 1889. This is illustrated in the statistics for several minerals as shown in this report. Thus, for example, the statistics for the production of marble, which show an increase in value of product between 1889 and 1902 of over $1,500,000, seem to show a decrease in the average number of wage-earners. Excluding the number of foremen and overseers for both years, the figures are as follows: 1889, 4,275; 1902, 4,070. But while the figures for 1902 represent the continuous employment of 4,070 men for 300 days, the average number of days worked by the 4,275 wage-earners in 1889, as the detailed statistics show, was only 255. Reduced to a 300-day basis, the average number of wage-earners for 1889 is found to be 3,648, thus showing that there has been a substantial increase during the decade.

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[1] This section and the sections following, Contract Mining and Quarrying and Contract Work, were prepared by Mr. Joseph D. Lewis, chief of the division of manufactures.

[2] The difference between the two methods of computing the average is practically the same as in the statistics for manufactures of the Eleventh and Twelfth censuses and is fully explained in the Report on Manufactures for the Twelfth Census. (See Part 1, pages cvi to cxi.) The instructions for verifying and correcting the number of wage-earners reported for 1902 are given in Appendix C.

It should be stated also that it is impracticable to make a comparison of the statistics of wage-earners and wages at the two censuses for the entire mining industry because the figures were not summarized for the earlier period.

Employees, by classes.—The following table summarizes the totals reported for 1902 in answer to that part of the inquiry which called for the average number of each class of salaried employees and wage-earners and the amounts paid them:

TABLE 36.—*Employees by classes: 1902.*

Salaried officials, clerks, etc.:	
Total number	38,128
Total salaries	$39,020,552
General officers—	
Number	1,591
Salaries	$8,218,541
Superintendents, managers, foremen above ground, surveyors, etc.—	
Number	15,538
Salaries	$16,666,416
Foremen below ground—	
Number	6,863
Salaries	$6,208,307
Clerks—	
Number	14,136
Salaries	$7,927,288
Wage-earners:	
Aggregate average number	581,728
Aggregate wages	$369,959,960
Above ground—	
Total average number	221,505
Total wages	$125,086,530
Engineers, firemen, machinists, blacksmiths, carpenters, and other mechanics—	
Average number	60,859
Wages	$44,478,246
Miners, quarrymen, and stonecutters—	
Average number	67,129
Wages	$33,971,290
Boys under 16 years—	
Average number	6,219
Wages	$1,339,478
All other wage-earners—	
Average number	87,298
Wages	$45,297,516
Below ground—	
Total average number	360,223
Total wages	$244,873,430
Miners—	
Average number	257,301
Wages	$184,674,193
Miners' helpers—	
Average number	18,736
Wages	$11,496,910
Boys under 16 years—	
Average number	5,638
Wages	$1,518,889
All other wage-earners—	
Average number	78,548
Wages	$47,183,438

Table 36 shows the number of all classes of employees reduced to the yearly average as above described, with the amount paid to each class in salaries and wages. Salaried officials, clerks, etc., usually receive annual or monthly salaries and, as a rule, are employed throughout the entire year; consequently, for this class, in a great majority of cases, it was unnecessary to make the reduction to the average for the year.

The employees shown in Table 36 may be arranged in two groups—first, the office force, which consisted of 15,727 general officers and clerks, receiving $16,145,829 as salaries, the number and salaries forming 2.5 and 3.9 per cent, respectively, of the totals for all employees; second, the employees engaged in supervising and in the actual work of the mines and quarries, which include the superintendents, managers, foremen, surveyors, etc., as well as the mechanics, the miners and their helpers, and all other wage-earners. This class numbered 604,129, and their salaries and wages amounted to $392,834,683, forming 97.5 and 96.1 per cent, respectively, of the totals. The superintendents, managers, foremen, and surveyors are classed as salaried officials though the distinction between foremen and miners is difficult to preserve, especially when there is very little, if any, difference in their wages.

Exclusive of the general officers and clerks, 237,043 employees, or 38.3 per cent of the total number were engaged in operations above ground, and the salaries and wages paid for such work amounted to $141,752,946, or 34.7 per cent of the total. The employees reported as engaged below ground numbered 367,086, or 59.2 per cent, and their salaries and wages amounted to $251,081,737, or 61.4 per cent of the total. The separation of employees so as to show the numbers working above and below ground can not be accepted as exact, because the same employees may, at different times, work in both places, and in some classes of mining the distinction between the two branches of work is not preserved uniformly. From Table 1, pages 348 to 361, it appears that employees working below ground were reported for the majority of the minerals; but of the total number of such employees 352,472, or all but 7,751, were employed in the mining of coal, iron, copper, gold and silver, and the salaries and wages they received amounted to $240,737,543, or all but $4,135,887 of the total salaries and wages paid for work below ground.

The miners, miners' helpers, quarrymen, and stonecutters, who may be accepted as the employees engaged in the actual work of removing the ore or mineral, and dressing the stone at the quarry, numbered 343,166, or 59 per cent of the total number of wage-earners, and their wages amounted to $230,142,393, or 62.2 per cent of the total wages.

Wage-earners, by occupations.—Table 37 shows the distribution of the several classes of wage-earners according to occupations, by minerals and groups of minerals.

TABLE 37.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO OCCUPATIONS, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	All wage-earners (number).	ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS, QUARRYMEN, AND STONECUTTERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
		Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.
Total	581,728	26,249	4.5	8,740	1.5	25,870	4.5	324,430	55.8	18,736	3.2	13,544	2.3	11,857	2.0	152,302	26.2
Metallic	110,384	3,763	3.4	2,037	1.9	6,643	6.0	55,124	49.9	7,730	7.0	3,558	3.2	689	0.6	30,850	28.0
Copper ore	26,017	552	2.1	487	1.9	1,819	7.0	12,821	49.3	1,257	4.8	863	3.3	103	0.4	8,105	31.2
Gold and silver	36,112	1,528	4.2	465	1.3	2,522	7.0	19,737	54.6	3,286	9.1	556	1.5	27	0.1	8,034	22.2
Iron ore	38,851	1,102	2.8	812	2.1	1,842	4.7	18,556	47.8	2,296	5.9	2,069	5.4	518	1.3	11,629	29.9
Lead and zinc ore	7,881	528	6.7	224	2.8	397	5.0	3,300	41.9	658	8.3	36	0.5	30	0.4	2,708	34.4
Manganese ore	194	15	7.7	7	3.6	4	2.1	96	49.5	3	1.5			13	6.7	56	28.9
Quicksilver	1,329	38	2.9	42	3.2	59	4.4	614	46.2	226	17.0	24	1.8	8	0.6	318	23.9
Fuels	372,569	19,148	5.1	5,134	1.4	14,189	3.8	207,040	55.6	10,558	2.8	9,820	2.6	10,194	2.7	96,452	25.9
Coal, anthracite	69,691	2,064	3.0	1,836	2.6	2,633	3.8	17,767	25.5	6,921	9.9	1,977	2.8	4,564	6.5	31,919	45.8
Coal, bituminous	280,638	3,781	1.3	3,112	1.1	6,739	2.4	189,273	67.4	3,637	1.3	7,843	2.8	5,628	2.0	60,625	21.6
Natural gas	4,678	352	7.5	121	2.6	1,074	23.0							2	(¹)	3,129	66.9
Petroleum	17,562	²12,955	73.8	65	0.4	3,757	21.4									779	4.4
Structural materials	86,295	2,909	3.4	1,287	1.5	4,419	5.1	54,476	63.1	237	0.3	22	(¹)	872	1.0	22,073	25.6
Cement	13,041	337	2.6	338	2.6	1,417	10.9	3,031	23.2	220	1.7	20	0.2	111	0.8	7,567	58.0
Clay	2,433	53	2.2	19	0.8	34	1.4	1,649	67.8	17	0.7	2	0.1	30	1.2	629	25.8
Limestones and dolomites	31,547	940	3.0	358	1.1	945	3.0	22,036	69.8					258	0.8	7,050	22.3
Marble	4,070	113	2.8	80	2.0	324	8.0	2,511	61.7					22	0.5	1,018	25.0
Sandstones and quartzites	10,448	329	3.1	241	2.3	178	1.6	7,117	68.1					76	0.7	2,007	19.2
Siliceous crystalline rocks	18,836	658	3.5	164	0.9	1,094	5.8	14,474	76.8					206	1.1	2,240	11.9
Slate	5,920	279	4.7	87	1.5	137	2.3	3,656	61.8					169	2.8	1,592	26.9
Abrasive materials	610	40	6.6	15	2.5	20	3.3	402	65.9	10	1.6			3	0.5	120	19.7
Buhrstones and millstones	86	2	2.3			2	2.3	80	93.1							2	2.3
Corundum and emery	47	4	8.5			2	4.3	23	48.9	10	21.3					8	17.0
Crystalline quartz	29	1	3.4					26	89.7							2	6.9
Garnet	118	4	3.4	1	0.9	5	4.2	61	51.7							47	39.8
Grindstones and pulpstones	210	24	11.4	14	6.7	10	4.8	118	56.2					2	0.9	42	20.0
Infusorial earth, tripoli, and pumice	35	2	5.7					23	65.7							10	28.6
Oilstones, whetstones, and scythestones	85	3	3.5			1	1.2	71	83.5					1	1.2	9	10.6
Chemical materials	8,845	278	3.1	227	2.6	277	3.1	5,539	62.7	144	1.6	128	1.5	55	0.6	2,197	24.8
Borax	153	8	5.2	3	2.0	6	3.9	66	43.1	27	17.7					43	28.1
Fluorspar	269	16	6.0	4	1.5	5	1.9	176	65.4	9	3.3			2	0.7	57	21.2
Gypsum	1,472	52	3.5	29	2.0	20	1.4	614	41.7					3	0.2	754	51.2
Phosphate rock	5,971	173	2.9	169	2.8	171	2.9	4,382	73.4			111	1.9	37	0.6	928	15.5
Sulphur and pyrite	970	29	3.0	22	2.3	75	7.7	301	31.0	108	11.1	17	1.8	13	1.3	405	41.8
Pigments	592	19	3.2	6	1.0	12	2.0	411	69.4	20	3.4	12	2.0	2	0.3	110	18.6
Barytes	336	2	0.6	2	0.6			321	95.5	1	0.3			2	0.6	8	2.4
Mineral pigments, crude	256	17	6.6	4	1.6	12	4.7	90	35.2	19	7.4	12	4.7			102	39.8
Miscellaneous	2,433	92	3.8	34	1.4	316	13.0	1,438	59.1	37	1.5	4	0.2	32	1.3	480	19.7
Asbestos	23	1	4.3	2	8.7	2	8.7	17	74.0							1	4.3
Asphaltum and bituminous rock	156	6	3.8	4	2.6	7	4.5	116	74.4	1	0.6	1	0.6			21	13.5
Bauxite	150	9	6.0	3	2.0	5	3.3	77	51.3					3	2.0	53	35.3
Feldspar	252	11	4.4	1	0.4	6	2.4	183	72.6					3	1.2	48	19.0
Flint	119	5	4.2	2	1.7	4	3.4	65	54.6							43	36.1
Fuller's earth	114	4	3.5	5	4.4	3	2.6	54	47.3					24	21.1	24	21.1
Graphite	164	8	4.9	1	0.6	18	11.0	87	53.0	6	3.7	3	1.8	1	0.6	40	24.4
Lithium ore	6							6	100.0								
Marl	13	1	7.7	1	7.7			10	76.9					1	7.7		
Mica	98	5	5.1	1	1.0	6	6.1	70	71.4	3	3.1					13	13.3
Monazite	88							86	97.7							2	2.3
Precious stones	108					4	3.7	79	73.2	5	4.6					20	18.5
Silica sand	335	21	6.2	3	0.9	8	2.4	149	44.5							154	46.0
Talc and soapstone	771	21	2.7	10	1.3	251	32.6	411	53.3	17	2.2					61	7.9
Tungsten	2							2	100.0								
Uranium and vanadium	19					2	10.5	17	89.5								
All other minerals ³	15			1	6.7			9	60.0	5	33.3						

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[1] Less than one-tenth of 1 per cent.
[2] Includes pumpmen.
[3] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Table 37 shows the relative proportions of the several classes of wage-earners that were required in the different branches of the mineral industry. The schedule of inquiry, of course, could not be made in sufficient detail to show separately all classes of occupations, and consequently a large number of wage-earners that in a complete presentation would be given separately are included in the class of "all other wage-earners." A very large proportion of this class, however, were common workmen or unskilled laborers. For the industry as a whole the percentages which the numbers of the different classes of wage-earners were of the total number are as follows: Engineers, 4.5 per cent; firemen, 1.5; mechanics, 4.5; miners, quarrymen, and stone cutters, 55.8; miners' helpers, 3.2; timbermen and track layers, 2.3; boys under 16 years, 2; all other wage-earners, 26.2.

So far as possible the minerals in Table 37 are arranged in groups according to their character or the uses to which they are put. For the reason that there is, as a rule, a similarity in the conditions of mining the minerals in the same groups, the statistics in each group are more comparable with each other than with those of different groups. A notable exception, however, is found in the group of fuels, in which the statistics for natural gas and petroleum are not at all analogous to those for coal, and are not in any sense comparable with them on account of the entirely different conditions governing production.

The conditions that chiefly affect the proportions of the several classes of wage-earners are the methods of mining, whether surface or underground, and whether the mineral is sold in the crude state or undergoes some process of manufacture at the mine before being marketed. If the mine workings are underground and are spread over a wide area, the proportion of miners is reduced and those of other classes are correspondingly increased. Conversely, in surface mining and quarrying, the proportion of those engaged in the work of getting out the mineral is, as a rule, larger than in the other branches. Any manufacturing process to which the product may be subjected at the mine or quarry before shipment necessarily increases the proportion of "all other wage-earners." This is plainly indicated in the statistics for cement, the finished cement being in every case manufactured in connection with quarrying the rock, and also to a slightly less degree in the case of gypsum, the work of manufacturing land plaster, wall or cement plaster, and plaster of Paris being done at the quarry. The proportions of "all other wage-earners" in these two industries were 58 and 51.2 per cent, respectively. The largest proportion in this miscellaneous group of employees, namely, 66.9 per cent, was for the natural gas industry, in which the principal work, after the equipment of the property is complete, is the distribution of the gas to the consumers; and the group of "all other wage-earners" was composed chiefly of the various classes of employees engaged in this part of the work. In this industry the mechanical force composed of machinists, blacksmiths, carpenters, and other mechanics, formed 23 per cent of the entire number of wage-earners. Upon comparing the statistics for petroleum with those for natural gas, it is found that the percentages for the mechanical force were almost identical in the two industries, but that in the petroleum industry the predominating class consisted of the engineers engaged in the work of pumping wells, these forming 73.8 per cent of the whole number. As shown by a comparison of anthracite and bituminous coal, the percentages for the mechanical force and for "all other wage-earners" were greater for the anthracite, while miners constituted a larger proportion in the case of bituminous. These are the natural results of the greater difficulty of anthracite mining and of the necessity of preparing the product for market after it is mined.

In addition to the foregoing and other facts that a critical analysis of Table 37 might disclose, it is shown that the mechanical force was especially large for cement, graphite, natural gas, petroleum, and talc and soapstone; that practically all the wage-earners employed were directly engaged in removing the mineral in the case of barytes, buhrstones and millstones, monazite, oilstones, whetstones, and scythestones; and that the proportion of employees included under "all other wage-earners" was considerably above the average in the case of cement, gypsum, mineral pigments, natural gas, and sulphur and pyrite.

Boys as wage-earners.—Provision was made in the schedule for reporting separately the men, and the boys under 16 years, employed as wage-earners. Table 38 shows for each mineral the number of men and boys employed, with the percentage that the number of each is of the total number of wage-earners.

TABLE 38.—*Wage-earners, men and boys, by minerals: 1902.*

MINERAL	Total average number.	MEN		BOYS UNDER 16 YEARS	
		Average number.	Per cent of total.	Average number.	Per cent of total.
Total	581,728	569,871	98.0	11,857	2.0
Asbestos	23	23	100.0		
Asphaltum and bituminous rock	136	136	100.0		
Barytes	336	334	99.4	2	0.6
Bauxite	150	147	98.0	3	2.0
Borax	173	173	100.0		
Buhrstones and millstones	86	86	100.0		
Cement	13,011	12,896	99.1	115	0.9
Clay	2,453	2,423	98.8	30	1.2
Coal, anthracite	69,691	65,130	93.5	4,561	6.5
Coal, bituminous	280,638	275,010	98.0	5,628	2.0
Copper ore	26,007	25,901	99.6	106	0.4
Corundum and emery	47	47	100.0		
Crystalline quartz	20	20	100.0		
Feldspar	252	249	98.8	3	1.2
Flint	119	119	100.0		
Fluorspar	269	267	99.3	2	0.7
Fuller's earth	114	90	78.9	24	21.1
Garnet	158	158	100.0		
Gold and silver	36,142	36,115	99.9	27	0.1
Graphite	164	163	99.4	1	0.6
Grindstones and pulpstones	210	208	99.1	2	0.9
Gypsum	1,472	1,469	99.8	3	0.2
Infusorial earth, tripoli, and pumice	35	35	100.0		
Iron ore	38,851	38,333	98.7	518	1.3
Lead and zinc ore	7,881	7,851	99.6	30	0.4
Limestones and dolomites	31,547	31,289	99.2	258	0.8
Lithium ore	6	6	100.0		
Manganese ore	194	181	93.3	13	6.7
Marble	4,070	4,048	99.5	22	0.5
Marl	13	12	92.3	1	7.7
Mica	98	98	100.0		
Mineral pigments, crude	256	256	100.0		
Monazite	88	88	100.0		
Natural gas	1,678	1,676	100.0	2	(1)
Oilstones, whetstones, and scythestones	85	84	98.8	1	1.2
Petroleum	17,552	17,552	100.0		
Phosphate rock	5,971	5,934	99.4	37	0.6
Precious stones	108	108	100.0		
Quicksilver	1,329	1,321	99.4	8	0.6
Sandstones and quartzites	10,448	10,372	99.3	76	0.7
Silica sand	335	335	100.0		
Siliceous crystalline rocks	18,836	18,630	98.9	206	1.1
Slate	5,920	5,751	97.2	169	2.8
Sulphur and pyrite	970	957	98.7	13	1.3
Talc and soapstone	771	771	100.0		
Tungsten	2	2	100.0		
Uranium and vanadium	19	19	100.0		
All other minerals[2]	15	15	100.0		

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[1] Less than one tenth of 1 per cent.

[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

The average number of wage-earners employed in the mining industry in 1902 was 581,728, of whom only 11,857, or 2 per cent, were boys under 16 years, which may be considered a small proportion. The statistics of manufactures show that there were 168,583 children under 16 years out of a total of 5,308,406 wage-earners, a percentage of 3.2, employed in the manufacturing industries in 1900. The reason for the small proportion of boys employed in mines and quarries is undoubtedly the arduous nature of the work and the rigorous conditions under which it is performed in many branches of the industry. Aside from the physical strength and endurance required in much of the work, it frequently has to be performed under conditions extremely injurious to health and of great hazard to life and limb.

In many of the industries, as shown by the table, no boys were found, and in most of the others the proportion was very small. The industries for which no boys were reported are as follows: Asbestos; asphaltum and bituminous rock; borax; buhrstones and millstones; corundum and emery; crystalline quartz; flint; garnet; infusorial earth, tripoli, and pumice; lithium ore; mica; mineral pigments, crude; monazite; petroleum; precious stones; silica sand; talc and soapstone; tungsten; uranium and vanadium; chrome ore; magnesite; molybdenum; nickel and cobalt; and rutile.

It should be observed that for the mineral industries giving employment to but a small number of wage-earners in the aggregate the percentages given may be, and no doubt are, in some cases entirely misleading, as the large proportion of boys may be due to circumstances which are entirely fortuitous. The highest percentage shown is for the mining of fuller's earth, for which 24 boys, or 21.1 per cent of the total number of wage-earners, were reported. They were nearly all reported by one large establishment and were employed at the lighter work, such as driving carts and performing certain parts of the processes of drying and grinding the product. When the product, after being mined, requires some preparation before shipment, the proportion of boys is always larger than when the mineral is sold in a crude condition. This is clearly shown in coal mining, in which industry there were among the employees in both branches, anthracite and bituminous, 10,192 boys, or 86 per cent of the total for the United States in all branches of the mining and quarrying industries. In anthracite mines there were 4,564 boys employed, or 6.5 per cent of the total number of wage-earners in that industry, and in bituminous mines there were 5,628, or 2 per cent of the total. The occupations commonly followed by boys below ground are mule driving and door tending. In anthracite mines the number of boys below ground was 1.1 per cent of the total number of wage-earners, and in bituminous 1.7 per cent, showing that a somewhat larger proportion of boys was required in underground work in bituminous mining than in anthracite. As a rule bituminous coal requires no preparation after being mined; the "run of mine" is usually marketed in that condition. Anthracite, on the other hand, is always crushed, screened, picked or cleaned, and in many instances washed before being shipped, and many boys are employed in the various stages of the process. This is clearly indicated by the statistics. In bituminous mining only three-tenths of 1 per cent of the total number of wage-earners were boys working above ground, while in anthracite mining such employees formed 5.5 per cent of the entire number.

It is especially noteworthy that for gold and silver mining, in which on an average 36,142 wage-earners were employed, only 27 boys, or one-tenth of 1 per cent of the total, were reported, and of this number only 6 worked underground. The number of boys reported in copper and in lead and zinc mining was also noticeably small.

Wage-earners employed during each month.—The statistics for the average number of wage-earners employed each month are summarized in the following table:

TABLE 39.—*Average number of wage-earners employed during each month: 1902.*

	Total	Men 16 years and over	Boys under 16 years.
Yearly average	581,728	569,871	11,857
January	605,602	590,162	15,440
February	602,635	587,181	15,454
March	611,026	595,413	15,613
April	620,166	604,359	15,807
May	596,870	586,464	10,406
June	525,464	518,197	7,267
July	516,870	509,596	7,274
August	528,532	521,389	7,143
September	537,433	529,932	7,501
October	575,796	566,191	9,605
November	646,922	631,639	15,283
December	643,220	627,629	15,591

The greatest number, 646,922, were employed in November. Exclusive of the coal mines, the greatest activity in the mining industries was during the summer months, the largest number being employed in August. The largest number were employed in the coal mines during December, but the strike in the anthracite coal region continued from May to October and greatly reduced the number employed during that period. The number employed each month in the production of the different minerals, shown in Table 40, indicates that in some branches of mining the operations were comparatively constant during the year, while in others the activity of the industry varied widely.

There is a natural division of mining operations into two main classes, surface and deep mining. Activity in the former is affected, as it is in outdoor industries generally, by the weather and by seasonal changes; while operations in the latter class, as a rule, are governed more by the market conditions. No idea can be obtained from Table 39 of the periods of activity and depression in particular branches of the mining industry, although it shows general conditions for the industry as a whole. It is not practicable to make a complete segregation of the statistics based on this division, as operations in some of the industries, iron ore for example, are conducted both on the surface and underground.

Reference to the detailed statistics in Table 1, page 348 of this report, will show for each branch of the mining industry the variations in the average number of wage-earners employed during each month. Table 40 shows the average number of wage-earners employed each month for the more important minerals—that is, those showing a yearly average of more than 2,000 wage-earners.

TABLE 40.—AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH, BY MINERALS, IN THE MINING OF WHICH MORE THAN 2,000 WERE EMPLOYED: 1902.

MONTH.	All minerals.	Cement.	Clay.	Coal, anthracite.	Coal, bituminous.	Copper ore.	Gold and silver.	Iron ore.	Lead and zinc ore.	Limestones and dolomites.	Marble.	Natural gas.	Petroleum.	Phosphate rock.	Sandstones and quartzites.	Siliceous crystalline rocks.	Slate.	All other minerals.
Yearly average	581,728	13,041	2,433	69,691	280,638	25,606	36,142	38,851	7,881	31,547	4,070	4,678	17,582	5,971	10,448	18,856	5,920	8,022
January	665,802	10,126	2,147	118,380	290,637	24,926	34,705	34,259	7,372	22,581	3,574	3,821	17,364	5,592	5,727	12,442	5,265	6,654
February	662,655	10,364	2,128	119,228	287,007	24,768	34,952	33,592	7,259	22,410	3,618	3,577	17,228	5,366	5,794	12,828	5,302	7,150
March	661,058	10,883	2,259	117,584	283,327	25,715	34,837	35,168	7,495	27,638	3,880	3,655	17,346	5,551	7,765	14,269	5,468	7,546
April	620,166	12,413	2,445	117,705	272,927	26,201	35,986	37,326	7,655	33,077	4,090	3,868	17,658	5,883	10,405	18,882	5,898	7,990
May	566,870	13,303	2,608	56,135	268,006	27,183	37,192	39,830	7,896	35,084	4,316	4,114	17,182	5,985	12,778	20,346	6,136	8,353
June	525,464	13,396	2,658	16,253	263,253	26,572	37,333	39,842	8,028	35,959	4,184	4,574	17,364	6,410	13,406	21,789	6,143	8,401
July	516,870	13,594	2,648	6,552	260,817	26,930	37,139	41,167	8,015	39,447	4,186	4,658	17,184	6,378	13,368	22,678	6,302	8,503
August	528,552	14,622	2,601	7,706	269,173	26,000	37,164	42,025	8,212	36,965	4,228	5,084	17,547	6,364	13,152	22,844	6,353	8,491
September	537,183	14,666	2,512	8,296	278,097	25,790	36,757	41,857	8,090	36,621	4,430	5,670	17,566	6,442	12,765	22,321	6,341	8,740
October	575,796	14,459	2,490	56,109	292,064	26,666	36,785	41,428	8,157	34,947	4,275	5,466	17,868	6,120	11,980	22,019	6,223	8,667
November	636,922	14,296	2,420	113,320	298,718	25,811	36,154	40,401	8,064	30,044	4,119	5,332	17,264	5,810	10,506	19,248	5,947	8,142
December	643,220	14,071	2,296	118,042	303,140	25,732	34,707	39,217	8,292	26,723	3,940	6,337	18,002	5,751	7,790	15,789	5,659	7,758

Of the minerals shown separately in Table 40, the production of clay appears to have been carried on with the greatest degree of regularity, the number employed varying only from 2,658 in June to 2,128 in February, while the number employed in the production of anthracite coal varied from 119,228 in February to 6,552 in July. This wide variation marked an abnormal condition—the great strike, which continued from May to October. While it seems that the strike affected all of the wage-earners in the coal industry, the operators were successful in most cases in securing the services of a sufficient number of men to protect their properties and to preserve them from deterioration and, in some instances, even to mine small quantities of coal.

In bituminous coal mining the largest number of wage-earners, 303,140, appears for December. The number fluctuates from month to month, reaching the lowest point, 260,817, in July.

Table 40 clearly indicates that in all kinds of mining and quarrying, where the work is done largely in the open air, the period of greatest activity is in summer, while the averages for the winter months denote a time of comparative depression. This condition is shown for clay, limestones and dolomites, marble, sandstones and quartzites, siliceous crystalline rocks, and slate, and also, although less pronounced, for cement, iron ore, and lead and zinc ore. Phosphate rock, being mined almost entirely in the South where the seasonal changes have less effect, shows a less marked reduction of the number of employees in the colder months than some of those just mentioned.

The variation in the average number of wage-earners in gold and silver mining was from 37,333 in June to 34,705 in January, and in copper mining from 27,183 in May to 24,768 in February.

Average earnings of wage-earners.—In considering the statistics of employees and wages included in this report it should be understood that it is not possible to draw from the figures any trustworthy conclusion regarding the average earnings of all those employed at stated wages, either by the day or piece. The division of the total amount paid in wages to the wage-earners of any industry or of any class by the number of wage-earners in the industry or class results in an unreal and deceptive amount, which is the quotient of the mathematical operation and nothing more. It does not represent the rate of wages of any one class of wage-earners.[1]

A part of the inquiry into employees and wages was framed for the purpose of bringing out the actual daily rates of pay received by the different classes of wage-earners, and this division of the general subject is treated on pages 96 to 101 of this report. While this class of wage statistics, i. e., actual wage rates, appears to receive the more general approval of statisticians, in preference to statistics purporting to represent average earnings, these rates, unless considered in connection with the duration of the period of employment, are liable to prove misleading. While a given rate represents the earnings of each wage-earner at that rate for a day's employment, it fails to furnish a true indication as to the annual earnings of the workman, and so falls short of being a correct index of his economic condition, which is better determined by the amount of wages paid to him annually. This is perhaps true more especially of mining and quarrying than of other lines of industry, as operations are frequently very irregular and spasmodic by reason of a fluctuating demand for the products.

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[1] This question is fully discussed in the Report on Manufactures for the Twelfth Census. See Part I, pages cxi to cxxv.

The statistics for anthracite coal may be taken as illustrating these points. Table 40 shows that for 1902 the least number of men, 6,552, was reported for July, and the greatest number, 119,228, for February. The strike of the anthracite coal miners lasted from May 12 to October 23, and the number employed in July may be said to represent the minimum, or the number required to preserve and protect the properties; while the number for February, giving due consideration to the fact that it is an average for the month, is the full quota finding employment in the industry. The amount paid in wages during the year was $38,716,113, and the division of this amount by the average number of wage-earners for the year, 69,691, results in a quotient of $555, which can be regarded only as an abstract quantity indicating the measure of the earnings of a theoretical average employee who worked full time during the year. This, in the light of the actual experience of those employed at anthracite mines in 1902, can only be considered as an ideal state of affairs.

Wage-earners at specified daily rates of pay. The inquiry designed to elicit the daily rates of pay of the wage-earners called for a distribution of the several classes according to their rates by 25-cent groups from 50 cents to $4.24, those receiving less than 50 cents and those receiving $4.25 or over to be combined into single groups. The exact rate of pay was not asked for, and in most cases the distribution of the employees within the 25-cent groups is not definitely known. It may be stated as a general proposition, however, that the greater proportion of the wage-earners included in the various 25-cent rate groups received the lowest rate of those groups. In the case of coal and iron ore miners and other employees paid in accordance with the amount of work done, very little can be said regarding daily rates of pay. When wage-earners are paid by the hour there is the same difficulty, for the daily rates are then naturally dependent upon the hours of employment. However, with the exception of coal and iron ore miners and some quarrymen, the great majority of the wage-earners employed in the mineral industries of the United States are paid by the day; and when employees are paid by the day their rates are more likely to be in multiples of 25 cents than otherwise. For example, the returns show that 6,742 of the men employed in copper mines received between $3.50 and $3.74 per day, and it may be safely stated that most of these men received $3.50 a day. For some minerals the daily rates of the several occupations are fixed at figures which are not multiples of 25 cents. But it would be more nearly correct to take the lowest rate in most wage groups as the rate paid to the greater number of the employees included within that group than it would be, for example, to consider the rate halfway between the limits of the group as an average for the entire group.

The distribution of the wage-earners according to these rates is shown in the following table for each mineral in the production of which more than 1,000 wage-earners were employed on the average during 1902. The table gives also the per cent that the number at each rate is of the total number; and the cumulative percentage at each rate, which shows what proportion of the total number received a wage as great as, or greater than, the lowest wage of the given wage group.

TABLE 41.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY MINERALS: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL MINERALS.			CEMENT.			CLAY.			COAL, ANTHRACITE.			COAL, BITUMINOUS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	581,728	100.0		13,041	100.0	..	2,433	100.0	....	69,691	100.0	......	280,068	100.0	....
Less than 0.50	538	0.1	100.0	37	0.3	100.0	11	0.4	100.0	70	0.1	100.0	117	(1)	100.0
0.50 to 0.74	4,677	0.8	99.9	20	0.2	99.7	44	1.8	99.6	2,439	3.5	99.9	1,139	0.4	99.9
0.75 to 0.99	11,054	1.9	99.1	192	1.5	99.5	330	13.6	97.8	3,808	5.5	96.4	2,720	1.0	99.6
1.00 to 1.24	33,563	5.8	97.2	1,099	8.4	98.0	494	20.3	84.2	6,566	9.4	90.9	8,084	2.9	98.6
1.25 to 1.49	45,101	7.8	91.4	3,849	29.5	89.6	871	35.8	63.9	8,495	12.2	81.5	11,928	4.2	95.7
1.50 to 1.74	78,102	13.4	83.6	4,107	31.5	60.1	322	13.2	28.1	10,712	15.4	69.3	32,034	11.4	91.5
1.75 to 1.99	75,554	13.0	70.2	1,632	12.5	28.6	89	3.7	14.9	11,547	16.6	53.9	36,797	13.1	80.1
2.00 to 2.24	110,689	19.0	57.2	933	7.1	16.1	121	5.0	11.2	8,150	11.7	37.3	70,909	25.3	67.0
2.25 to 2.49	73,665	12.7	38.2	427	3.3	9.0	65	2.7	6.2	7,253	10.4	25.6	43,609	15.5	41.7
2.50 to 2.74	52,837	9.1	25.5	433	3.3	5.7	68	2.8	3.5	3,132	4.5	15.2	32,451	11.6	26.2
2.75 to 2.99	24,446	4.2	16.4	103	0.8	2.4	7	0.3	0.7	1,819	2.6	10.7	15,814	5.6	14.6
3.00 to 3.24	31,577	5.4	12.2	125	1.0	1.6	10	0.4	0.4	1,806	2.6	8.1	12,038	4.3	9.0
3.25 to 3.49	10,743	1.8	6.8	47	0.4	0.6	1	(1)	(1)	1,382	2.0	5.5	6,470	2.3	4.7
3.50 to 3.74	20,324	3.5	5.0	19	0.2	0.2	......	......	......	1,317	1.9	3.5	4,402	1.6	2.4
3.75 to 3.99	2,397	0.4	1.5	7	(1)	....	......	......	......	517	0.7	1.6	1,324	0.5	0.8
4.00 to 4.24	4,214	0.7	1.1	7	(1)	....	......	......	......	167	0.2	0.9	495	0.2	0.3
4.25 and over	2,317	0.4	0.4	4	(1)	....	......	......	......	502	0.7	0.7	404	0.1	0.1

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[1] Less than one-tenth of 1 per cent.

TABLE 41.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY MINERALS: 1902—Cont'd.

RATE PER DAY (DOLLARS).	COPPER.			GOLD AND SILVER.			GYPSUM.			IRON ORE.			LEAD AND ZINC ORE.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage	Average number	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number	Per cent of total.	Cumulative per centage.
Total	26,007	100.0	....	36,142	100.0	....	1,472	100.0	....	38,851	100.0	....	7,881	100.0	....
Less than 0.50	....	....	....	4	(1)	100.0	....	....	....	141	0.4	100.0	5	0.1	100.0
0.50 to 0.74	29	0.1	100.0	51	0.1	99.9	3	0.2	100.0	279	0.7	99.6	14	0.2	99.9
0.75 to 0.99	49	0.2	99.9	234	0.6	99.9	1	0.1	99.8	853	2.2	98.9	7	0.1	99.7
1.00 to 1.24	201	0.8	99.7	369	1.0	99.3	33	2.2	99.7	4,618	11.9	96.7	165	2.1	99.6
1.25 to 1.49	368	1.4	98.9	218	0.6	98.3	82	5.6	97.5	2,874	7.4	84.8	1,371	17.4	97.5
1.50 to 1.74	1,847	7.1	97.5	285	0.8	97.7	754	51.2	91.9	5,468	14.1	77.4	2,053	26.0	80.1
1.75 to 1.99	3,354	12.9	90.4	580	1.6	96.9	339	23.0	40.7	7,344	18.9	63.3	683	8.7	54.1
2.00 to 2.24	6,277	24.1	77.5	1,180	3.3	95.3	150	10.2	17.7	8,556	22.0	44.4	2,301	29.2	45.4
2.25 to 2.49	2,066	8.0	53.4	783	2.2	92.1	49	3.3	7.5	4,862	12.5	22.4	788	10.0	16.2
2.50 to 2.74	2,285	8.8	45.4	5,527	15.3	89.8	37	2.5	4.2	2,511	6.4	9.9	309	3.9	6.2
2.75 to 2.99	661	2.5	36.6	2,884	8.0	74.5	....	....	1.7	639	1.6	3.5	26	0.3	2.3
3.00 to 3.24	961	3.7	34.1	12,166	33.7	66.5	20	1.4	1.7	454	1.2	1.9	143	1.8	2.0
3.25 to 3.49	131	0.5	30.4	1,614	4.5	32.8	....	....	0.3	77	0.2	0.7	10	0.1	0.2
3.50 to 3.74	6,742	25.9	29.9	6,873	19.0	28.3	....	....	0.3	125	0.3	0.5	4	0.1	0.1
3.75 to 3.99	54	0.2	4.0	345	0.9	9.3	....	....	0.3	7	(1)	0.2	1	(1)	(1)
4.00 to 4.24	605	2.3	3.8	2,551	7.1	8.4	3	0.2	0.3	39	0.1	0.2	1	(1)	(1)
4.25 and over	377	1.5	1.5	471	1.3	1.3	1	0.1	0.1	43	0.1	0.1	....	....	....

RATE PER DAY (DOLLARS).	LIMESTONES AND DOLOMITES.			MARBLE.			NATURAL GAS.			PETROLEUM.			PHOSPHATE ROCK.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage	Average number.	Per cent of total.	Cumulative percentage.
Total	31,547	100.0	....	4,070	100.0	....	4,678	100.0	....	17,552	100.0	....	5,971	100.0	....
Less than 0.50	16	0.1	100.0	6	0.1	100.0	....	....	....	1	(1)	100.0	52	0.9	100.0
0.50 to 0.74	196	0.6	99.9	17	0.4	99.9	2	(1)	100.0	1	(1)	99.9	89	1.5	99.1
0.75 to 0.99	389	1.2	99.3	61	1.5	99.5	11	0.2	99.9	4	(1)	99.9	1,288	21.6	97.6
1.00 to 1.24	4,126	13.1	98.1	558	13.7	98.0	28	0.6	99.8	74	0.4	99.9	3,656	61.2	76.0
1.25 to 1.49	7,870	24.9	85.0	963	23.7	84.3	248	5.3	99.2	61	0.4	99.6	378	6.3	11.8
1.50 to 1.74	9,196	29.1	60.1	858	21.1	60.6	1,230	26.3	93.9	699	4.0	99.2	250	4.2	8.5
1.75 to 1.99	4,944	15.7	31.0	286	7.0	39.5	873	18.7	67.6	1,078	6.1	95.2	25	0.4	4.3
2.00 to 2.24	2,637	8.4	15.3	293	7.2	32.5	1,090	23.3	48.9	1,403	8.0	89.1	101	1.7	3.9
2.25 to 2.49	885	2.8	6.9	182	4.5	25.3	558	11.9	25.6	10,046	57.2	81.1	33	0.6	2.2
2.50 to 2.74	580	1.8	4.1	291	7.2	20.8	326	7.0	13.7	2,366	13.5	23.9	55	0.9	1.6
2.75 to 2.99	193	0.6	2.3	159	3.9	13.6	72	1.6	6.7	242	1.4	10.4	3	(1)	0.7
3.00 to 3.24	218	0.7	1.7	130	3.2	9.7	67	1.4	5.1	859	4.9	9.0	21	0.4	0.7
3.25 to 3.49	114	0.4	1.0	82	2.0	6.5	8	0.2	3.7	277	1.6	4.1	....	....	0.3
3.50 to 3.74	121	0.4	0.6	57	1.4	4.5	28	0.6	3.5	89	0.5	2.5	4	0.1	0.3
3.75 to 3.99	1	(1)	0.2	4	0.1	3.1	37	0.8	2.9	38	0.2	2.0	3	(1)	0.2
4.00 to 4.24	58	0.2	0.2	15	0.4	3.0	34	0.7	2.1	25	0.1	1.8	5	0.1	0.2
4.25 and over	4	(1)	(1)	105	2.6	2.6	66	1.4	1.4	289	1.7	1.7	8	0.1	0.1

RATE PER DAY (DOLLARS)	QUICKSILVER.			SANDSTONES AND QUARTZITES.			SILICEOUS CRYSTALLINE ROCKS.			SLATE.			ALL OTHER MINERALS.		
	Average number.	Per cent of total	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	1,329	100.0	....	10,118	100.0	....	18,836	100.0	....	5,920	100.0	....	5,221	100.0	....
Less than 0.50	2	0.1	100.0	4	(1)	100.0	37	0.2	100.0	7	0.1	100.0	28	0.5	100.0
0.50 to 0.74	22	1.7	99.9	40	0.4	99.9	133	0.7	99.8	72	1.2	99.9	64	1.2	99.5
0.75 to 0.99	10	0.7	98.2	60	0.6	99.6	573	3.0	99.1	101	1.7	98.7	363	7.0	98.3
1.00 to 1.24	113	8.5	97.5	292	2.8	99.0	1,282	6.8	96.1	290	4.9	97.0	1,475	28.2	91.3
1.25 to 1.49	211	15.9	89.0	1,155	11.4	96.2	2,096	11.1	89.3	983	16.6	92.1	1,040	19.9	63.1
1.50 to 1.74	56	4.2	73.1	2,357	23.3	84.8	3,546	18.8	78.2	1,145	19.4	75.5	1,106	21.2	43.2
1.75 to 1.99	163	12.3	68.9	1,736	17.2	61.5	3,045	16.2	59.4	658	11.1	56.1	320	6.1	22.0
2.00 to 2.24	195	14.7	56.6	2,145	21.2	44.3	2,483	13.2	43.2	1,369	23.1	45.0	338	6.5	15.9
2.25 to 2.49	160	12.0	41.9	464	4.6	23.1	692	3.7	30.0	671	11.3	21.9	52	1.0	9.4
2.50 to 2.74	299	22.5	29.9	436	4.3	18.5	1,141	6.1	26.3	349	5.9	10.6	225	4.3	8.4
2.75 to 2.99	14	1.1	7.4	253	2.5	14.2	1,361	7.2	20.2	161	2.7	4.7	35	0.7	4.1
3.00 to 3.24	78	5.9	6.4	634	6.3	11.7	1,608	8.5	13.0	105	1.8	2.0	114	2.2	3.4
3.25 to 3.49	4	0.3	0.4	110	1.1	5.4	480	2.5	4.5	4	0.1	0.2	22	0.4	1.2
3.50 to 3.74	1	0.1	0.1	304	3.0	4.3	199	1.1	2.0	4	0.1	0.1	25	0.5	0.8
3.75 to 3.99	....	....	....	23	0.2	1.3	28	0.1	0.9	....	....	(1)	10	0.2	0.3
4.00 to 4.24	....	....	....	86	0.8	1.1	125	0.7	0.8	....	....	(1)	4	0.1	0.1
4.25 and over	....	....	....	30	0.3	0.3	9	0.1	0.1	1	(1)	(1)	....	....	....

[1] Less than one-tenth of 1 per cent.

The production of the minerals for which separate statistics are shown in Table 41 gave employment to 576,507 wage-earners, this number forming 99.1 per cent of the 581,728 wage-earners reported for all mines and quarries. The average number and per cent of the total number are shown in the table for each rate group. The percentages are also accumulated.

The cumulative percentage is obtained by combining the figures which represent the per cent of total. For example, in Table 41, under the head of "all minerals," four-tenths of 1 per cent of the wage-earners received $4.25 or over and seven-tenths of 1 per cent received between $4 and $4.24; adding the two percentages, it is found that 1.1 per cent received $4 per day or over.

This process is continued throughout the wage scale until all the wage-earners have been included, when the cumulative percentage naturally becomes 100 per cent. The cumulative percentage, as stated opposite any wage group, shows then the percentage of the total number formed by the sum of the number included in that wage group plus the number included in all the higher wage groups.

Two advantages are gained by the use of the cumulative percentage. In the first place, it is possible to determine at a glance the proportion of the total number receiving as much as, or more than, a given rate. For example, if the cumulative percentages were not given in the preceding table, and it were desired to obtain the proportion of the total number who received $1.50 per day or over, it would be necessary to add the nine numbers representing the percentages at each rate from $1.50 up. In the cumulative percentage column this addition is already made, and it is evident at a glance that 60.1 per cent of the cement workers received at least $1.50 per day.

The second advantage gained by the use of the cumulative percentage lies in the fact that it is possible to compare two given sets of returns much more readily than by either the numbers or the percentages in the respective groups. For example, in Table 41 the column headed "cumulative percentage" shows that for cement workers the proportion of the total number receiving $1 per day or more was 98 per cent, while for clayworkers it was 84.2 per cent. At $1.50 the respective proportions were 60.1 and 28.1 per cent, and at $2 they were 16.1 and 11.2 per cent. The cumulative percentages thus show that wages were higher in 1902 for cement workers than for workers in clay mining.

Of the various minerals for which statistics are shown separately in the above table the production of anthracite and bituminous coal gave employment to the greatest number of wage-earners. A very large proportion of the miners in the coal mines were paid according to the quantity of their product, and some of the principal coal companies were unable to classify these employees according to the specified daily rates of pay. When data of this character were not reported by the company estimates were made in the Bureau of the Census from the total number of such employees reported, the total amount of wages paid, and the number of days that the mine was in operation, the rate being determined by the average daily earnings for the time employed, and the average number for the entire year being computed as previously explained; therefore, in such cases all employees of a mine who were paid by the piece or quantity of work done as measured by their output were estimated as receiving a uniform daily rate of pay. There were 230,846 employees reported as the average number receiving wages according to the quantity of their production, and they were paid $155,578,988. Of this number, 211,710, or 91.7 per cent, were reported for anthracite and bituminous coal, and they received $144,628,436, or 93 per cent of the amount paid for such mining in all minerals.

When the figures for all minerals are combined, it is found that the range of wages for practically all of the wage-earners was from $1 to $3.74 per day, 556,531, or 95.7 per cent of the total number employed, being included between those rates. Less than 3 per cent of the total number received less than $1 per day, and only 1.5 per cent received $3.75 or over. The four rate groups that lead in the number of employees included are consecutive and constitute the range from $1.50 to $2.49 per day. Between those limits is included 58.1 per cent of the total number. It should be added, however, that the proportion at $2.50 or over is much greater than that at less than $1.50. Of the total number of wage-earners, 57.2 per cent were paid $2 per day or more. An attempt to find the median rate (that is, a rate such that half the number of wage-earners receives that rate or more and the other half receives that rate or less) discloses the fact that this rate lies somewhere in the group $2 to $2.24. It will also be noticed that the rate group that includes the median includes a greater number of wage-earners than any other group in the scale.

In regard to the various minerals, the figures shown in Table 41 may be briefly summarized as follows:

Cement: Of the total number of wage-earners, 73.5 per cent were paid from $1.25 to $1.99.

Clay: The range of wages for 82.9 per cent of the total number was from $0.75 to $1.74; 35.8 per cent were included in the single rate group $1.25 to $1.49.

Coal: For a large number of coal miners the figures given represent average earnings and not rates, as most of these employees are paid by the ton or other unit. As the figures stand, they show that for anthracite coal 75.7 per cent of the employees received between $1 and $2.49, and for bituminous coal 76.9 per cent received between $1.50 and $2.74.

Copper ore: A wide range is noticeable in the wages paid to employees engaged in copper mining. Of the total number 24.1 per cent received between $2 and $2.24, and 25.9 per cent were paid from $3.50 to $3.74; the remaining wage-earners were distributed in smaller groups throughout the scale from $0.50 to $4.25 and over.

Gold and silver: Employees engaged in the mining of gold and silver were largely concentrated in three groups as follows: 15.3 per cent from $2.50 to $2.74; 33.7 per cent from $3 to $3.24; and 19 per cent from $3.50 to $3.74.

Gypsum: The range of wages for 84.4 per cent of the wage-earners was from $1.50 to $2.24; 51.2 per cent received from $1.50 to $1.74.

Iron ore: Of the total number of wage-earners, 86.8 per cent received between $1 and $2.49; the greatest concentration was at $2; 40.9 per cent of the total number received between $1.75 and $2.24.

Lead and zinc ore: Almost all, 91.3 per cent, of the wage-earners received between $1.25 and $2.49 per day; 26 per cent receiving from $1.50 to $1.74; and 29.2 per cent from $2 to $2.24.

Limestones and dolomites: The range of wages for 91.2 per cent of the total number was from $1 to $2.24. Here again there was a marked concentration at two rate groups, 24.9 per cent receiving from $1.25 to $1.49, and 29.1 per cent from $1.50 to $1.74.

Marble: The returns for wage-earners engaged in quarrying marble show a less marked concentration than is observable in most other minerals. There were, however, 58.5 per cent of the total number between the rates $1 and $1.74.

Natural gas: For 92.5 per cent of the wage-earners the range was from $1.25 to $2.74. The two wage groups showing the greatest number are as follows: $1.50 to $1.74, 26.3 per cent; $2 to $2.24, 23.3 per cent.

Petroleum: For 70.7 per cent of the total number of wage-earners the range of wages was from $2.25 to $2.74 per day, 57.2 per cent being included in the single rate group $2.25 to $2.49.

Phosphate rock: Almost all the wage-earners received less than $1.25, 82.8 per cent getting between $0.75 and $1.24. In the wage group $1 to $1.24, there were 61.2 per cent of the total number.

Quicksilver: The range of wages for the bulk of the employees was from $1.25 to $2.74, 81.6 per cent being included within those rates.

Sandstones and quartzites: The range of wages for 73.1 per cent of the total number was from $1.25 to $2.24.

Siliceous crystalline rocks: The figures show less concentration than for most of the other minerals; more than half, 59.3 per cent, of the total number, however, received between $1.25 and $2.24 per day.

Slate: In the quarrying of slate the rates for 81.5 per cent of the total number of wage-earners ranged from $1.25 to $2.49. The greatest concentration was in the wage group $2 to $2.24, which showed 23.1 per cent of the total number.

An examination of the cumulative percentages shows that wages were far higher for employees in gold and silver mines than for any other mineral, 66.5 per cent of all the wage-earners receiving $3 or over. Employees in copper mines were next highest paid, 29.9 per cent receiving $3.50 or over, and 77.5 per cent getting at least $2. Of the men employed in connection with petroleum wells, almost 90 per cent received $2 or over, but only 9 per cent of these received as much as $3. After gold and silver, copper, and petroleum the minerals showing the highest rates of wages are bituminous coal, quicksilver, natural gas, sandstones and quartzites, and siliceous crystalline rocks, in the order named. Following these come a large class of minerals which show very little difference in daily rates of pay, when all the wage-earners are considered as one group without distinction as to geographic location or specified occupation. These minerals are anthracite coal, iron ore, lead and zinc ore, marble, and slate. As will be shown later, when these minerals are considered by states and the wage-earners separated into the several classes, considerable variation in the rates are found. The rates of pay for men employed in quarrying phosphate rock were lower than those for any other mineral, only 14.8 per cent getting as much as $1.25 a day. This industry was practically confined to Florida, South Carolina, and Tennessee.

The number of wage-earners employed in the different occupations is an important factor to be considered in connection with these statistics, and the following table summarizes the returns for all minerals so as to show the average number receiving stated daily rates of pay in each occupation and the percentage which the number at each rate forms of the total number in the class:

TABLE 42.—AVERAGE NUMBER OF WAGE-EARNERS, AND PER CENT OF TOTAL NUMBER, AT SPECIFIED DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL WAGE-EARNERS.		ENGINEERS.[1]		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS, QUARRYMEN, AND STONECUTTERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.
Total	581,728	100.0	26,249	100.0	8,760	100.0	25,870	100.0	324,450	100.0	18,736	100.0	13,544	100.0	11,887	100.0	152,302	100.0
Less than 0.50	538	0.1	1	(²)	......	......	......	......	29	(²)	......	......	......	......	447	3.8	61	(²)
0.50 to 0.74	4,677	0.8	6	(²)	6	0.1	8	(²)	222	0.1	26	0.1	1	(²)	3,448	29.1	960	0.6
0.75 to 0.99	11,054	1.9	23	0.1	50	0.6	174	0.7	2,832	0.9	252	1.4	46	0.3	4,062	34.2	3,615	2.4
1.00 to 1.24	33,883	5.8	273	1.0	281	3.2	400	1.6	14,978	4.6	1,190	6.4	209	1.6	3,212	27.1	12,960	8.5
1.25 to 1.49	45,101	7.8	569	2.2	676	7.7	798	3.1	18,903	5.8	2,004	10.7	381	2.8	419	3.5	21,351	14.0
1.50 to 1.74	78,102	13.4	1,264	4.8	1,646	18.8	2,331	9.0	36,569	11.3	2,609	13.9	1,119	8.3	130	1.1	32,442	21.3
1.75 to 1.99	75,554	13.0	1,813	6.9	2,422	27.7	2,892	11.2	37,492	11.6	3,692	19.7	2,102	15.5	61	0.5	25,073	16.5
2.00 to 2.24	110,689	19.0	3,884	14.8	1,945	22.3	5,155	19.9	65,307	20.1	3,021	16.1	3,778	27.9	56	0.5	27,543	18.1
2.25 to 2.49	73,065	12.7	11,500	43.8	457	5.2	3,916	15.1	39,985	12.3	1,907	10.2	3,640	26.9	22	0.2	12,328	8.1
2.50 to 2.74	52,857	9.1	3,546	13.5	562	6.4	3,153	12.2	36,721	11.3	1,429	7.6	954	7.0	......	......	6,472	4.3
2.75 to 2.99	24,446	4.2	607	2.3	111	1.3	1,185	4.6	19,446	6.0	488	2.6	312	2.3	......	......	2,297	1.5
3.00 to 3.24	31,575	5.4	1,101	4.2	244	2.8	2,151	8.3	22,107	6.9	1,188	6.3	399	3.0	......	......	4,299	2.8
3.25 to 3.49	10,738	1.8	186	0.7	20	0.2	587	2.3	8,854	2.7	392	2.1	59	0.4	......	......	625	0.4
3.50 to 3.74	20,324	3.5	452	1.7	267	3.1	1,021	4.0	16,094	5.0	541	2.9	456	3.4	......	......	1,493	1.0
3.75 to 3.99	2,597	0.4	89	0.3	6	0.1	157	0.5	2,078	0.6	5	(²)	26	0.2	......	......	66	(²)
4.00 to 4.24	4,214	0.7	762	2.9	38	0.4	1,141	4.4	1,750	0.5	4	(²)	57	0.4	......	......	499	0.3
4.25 and over	2,317	0.4	173	0.7	9	0.1	799	3.1	1,063	0.3	......	......	5	(²)	......	......	268	0.2

[1] Includes pumpmen employed at petroleum and natural-gas wells.

[2] Less than one-tenth of 1 per cent.

Of the total number of wage-earners considered in the preceding tables, 11,857 were boys under 16 years of age, and nearly all of them received less than $1.25 per day. It will be noticed that the employees in the three lowest wage groups were very largely boys. For all occupations combined the range of wages for 58.1 per cent of the total number was from $1.50 to $2.49 per day. For 16.4 per cent the rates were less than $1.50, and the balance, 25.5 per cent, received $2.50 or over. Of the miners, quarrymen, and stonecutters, 66.6 per cent received between $1.50 and $2.74 per day, leaving 11.4 per cent who received less than $1.50 and 22 per cent who received $2.75 or more. The group of "all other wage-earners" is the next most important class in point of numbers. The figures for this class of employees show the following distribution: Less than $1.25, 11.5 per cent; between $1.25 and $2.24, 69.9 per cent; $2.25 or over, 18.6 per cent. There is a marked excess at the higher rates of pay for engineers, 70.1 per cent receiving $2.25 a day or over; a very large proportion of these were pumpmen employed at petroleum wells. The great majority of the timbermen and track layers were concentrated in the three groups between $1.75 and $2.49, 70.3 per cent being included between these rates. There was less concentration among the miners' helpers, the range of wages for 79.6 per cent of them being from $1.25 to $2.49.

The distribution of wage-earners according to daily rates of pay, by states and territories, is shown in the following table:

TABLE 43.—AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Total.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
United States	581,728	538	4,677	11,051	33,503	45,101	78,102	75,554	110,089	73,665	52,837	21,446	31,577	10,733	20,324	2,397	4,214	2,817
Alabama	19,132	43	154	639	2,639	2,455	3,183	2,692	2,333	970	2,990	657	291	80	5	.....	1	.....
Arizona	5,323	.....	.....	.....	20	26	58	686	525	625	283	242	746	202	1,520	51	280	60
Arkansas	2,944	3	8	41	134	161	393	303	347	561	368	380	195	.....	2	45	3	.....
California[1]	12,964	2	22	13	36	262	222	589	1,635	798	4,072	1,203	3,016	214	447	56	297	180
Colorado	20,519	.....	1	3	138	203	189	1,086	1,476	1,209	2,867	2,790	6,482	794	1,355	355	1,353	219
Connecticut	1,497	.....	1	8	35	174	618	295	127	27	24	91	63	18	16	.....	.....	.....
Delaware	504	.....	.....	1	27	253	186	28	9	9	6	1	.....	.....	1	3	.....	.....
Florida	3,146	6	8	447	2,063	211	234	20	76	30	24	4	7	.....	3	3	4	6
Georgia	2,820	48	77	492	1,147	431	231	51	63	41	17	26	114	40	31	.....	8	.....
Idaho	3,563	1	.....	3	22	10	8	11	27	10	52	64	918	597	1,554	11	241	34
Illinois	40,523	9	42	99	966	915	3,287	5,488	12,776	5,991	4,564	2,128	2,482	892	570	149	69	96
Indian Territory	4,814	.....	1	63	154	379	384	451	1,092	786	489	249	685	38	43	.....	.....	5
Indiana	16,473	2	25	49	369	1,376	2,042	1,451	2,559	5,064	1,529	809	464	257	375	21	51	37
Iowa	10,437	.....	7	17	186	164	1,101	1,299	3,741	1,497	1,552	278	350	31	176	34	1	.....
Kansas	8,726	2	3	27	177	404	1,356	1,112	1,661	1,465	1,093	1,040	197	173	72	20	6	18
Kentucky	10,664	18	212	314	1,430	1,751	2,098	1,714	1,888	710	319	73	13	42	5	6	32	14
Louisiana	61	.....	.....	.....	.....	.....	50	6	2	.....	2	.....	.....	.....	.....	.....	.....	1
Maine	3,684	.....	3	15	60	300	937	880	411	179	208	287	365	29	9	.....	1	.....
Maryland	6,926	8	77	66	398	755	893	772	670	1,125	475	879	319	95	52	219	1	12
Massachusetts	4,242	1	7	21	89	228	968	845	841	200	309	393	259	13	11	2	23	.....
Michigan	31,951	.....	4	21	258	129	4,462	7,010	10,363	4,883	3,304	477	547	89	21	8	19	56
Minnesota	9,760	2	4	2	17	32	281	2,219	3,820	1,436	973	396	191	221	96	20	21	29
Missouri	15,351	29	56	83	461	2,107	2,645	2,274	4,381	1,701	903	383	290	86	34	1	16	1
Montana	10,539	.....	.....	.....	14	4	5	4	29	170	210	301	886	159	7,572	67	689	429
Nebraska	178	.....	.....	1	2	1	8	151	8	5	.....	.....	2	.....	.....	.....	.....	.....
Nevada	1,132	.....	.....	1	.....	.....	72	14	33	3	23	75	443	12	96	2	294	64
New Hampshire	1,253	.....	1	3	39	37	214	383	106	40	40	185	163	27	5	1	6	3
New Jersey	5,645	.....	15	17	152	2,172	1,995	697	292	71	128	19	59	6	10	.....	8	4
New Mexico	2,275	.....	.....	3	12	157	416	180	141	108	329	131	576	39	67	52	22	17
New York	9,560	1	18	55	420	1,518	3,699	1,166	1,194	596	243	103	197	95	102	7	21	95
North Carolina	1,556	9	89	459	657	142	65	41	60	3	27	.....	4	.....	.....	.....	.....	.....
North Dakota	298	.....	1	1	1	7	63	18	69	53	68	8	10	.....	.....	1	.....	.....
Ohio	37,173	3	37	217	718	1,317	7,058	3,914	10,691	7,239	3,734	1,095	409	127	326	55	47	166
Oklahoma	128	.....	.....	1	6	5	83	8	11	1	6	.....	1	.....	3	.....	.....	.....
Oregon	1,166	.....	.....	1	12	1	28	11	292	45	170	95	301	40	114	3	40	10
Pennsylvania	190,965	113	2,721	4,997	10,472	18,865	27,250	27,763	35,184	27,930	14,164	6,094	4,651	5,375	3,468	820	294	558
Rhode Island	667	.....	1	22	7	49	107	73	74	20	44	109	121	10	3	2	4	1
South Carolina	2,694	54	152	1,199	785	171	66	11	31	1	53	.....	113	40	14	.....	2	2
South Dakota	3,131	.....	2	1	2	7	10	58	74	13	277	11	947	12	1,523	5	115	94
Tennessee	10,890	30	294	689	3,237	1,178	2,224	1,215	956	517	280	82	230	5	8	.....	.....	.....
Texas	3,853	8	69	187	290	900	448	420	841	73	294	32	264	32	47	7	22	29
Utah	5,712	1	2	1	28	8	37	60	343	797	1,448	1,436	1,004	138	301	33	56	19
Vermont	5,398	.....	14	43	141	791	1,057	983	1,030	355	304	349	255	71	4	1	10	10
Virginia	8,993	137	248	473	4,392	1,451	790	426	653	290	70	19	39	3	9	1	.....	2
Washington	4,567	1	6	8	24	31	107	125	330	691	466	574	1,814	147	129	14	92	4
West Virginia	30,002	12	287	390	1,176	3,362	5,339	5,127	5,544	4,337	2,549	657	701	392	54	12	42	21
Wisconsin	3,583	.....	8	10	60	103	1,063	1,170	745	167	78	43	58	25	8	1	3	.....
Wyoming	4,486	.....	.....	1	20	21	84	291	913	826	1,381	208	310	72	60	248	20	31

[1] Includes the employees of 2 operators in Alaska and of 1 operator in Hawaii.

Only the state totals are shown in the above table, the statistics for the various minerals in each state and for the several classes of employees being combined. The distribution of the various minerals throughout the United States differs so much that, while this table is of interest as showing the total number of wage-earners at the various rates of pay in the several states, a comparison of the rates paid in one state with those paid in another is of little value unless the minerals in each state are kept in mind. Thus, according to the figures presented, rates were highest in Montana and lowest in Florida. But since the greater part of the wage-earners in Montana were employed in copper and gold and silver mines, while those in Florida were employed in quarrying phosphate rock, the difference in wages is hardly significant.

It will be observed that the states reporting a large number of employees at the low rates are Southern states, while those reporting the greatest proportion at high rates are Western states. The difference in wages, according to geographic location, is more clearly shown in the following table, in which the figures for the various states are combined in five groups. The percentage of the total number at each rate is given for each group, as are also the cumulative percentages.

TABLE 44.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY GEOGRAPHIC DIVISIONS: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			NORTH ATLANTIC DIVISION.			SOUTH ATLANTIC DIVISION.			NORTH CENTRAL DIVISION.			SOUTH CENTRAL DIVISION.			WESTERN DIVISION.		
	Average number	Per cent of total	Cumulative percentage	Average number	Per cent of total.	Cumulative percentage	Average number.	Per cent of total.	Cumulative percentage	Average number	Per cent of total	Cumulative percentage	Average number	Per cent of total	Cumulative percentage	Average number	Per cent of total	Cumulative percentage
Total...	581,728	100.0	....	222,881	100.0	......	56,541	100.0	......	177,584	100.0	......	52,476	100.0	......	72,246	100.0	......
Less than 0.50.	538	0.1	100.0	115	0.1	100.0	274	0.5	100.0	47	(a)	100.0	97	0.2	100.0	5	(a)	100.0
0.50 to 0.74....	4,677	0.8	99.9	2,781	1.2	99.9	938	1.7	99.5	189	0.1	99.9	738	1.4	99.8	31	0.1	99.9
0.75 to 0.99....	11,054	1.9	99.1	5,081	2.3	98.7	3,527	6.2	97.8	528	0.3	99.9	1,881	3.6	98.4	34	0.1	99.9
1.00 to 1.24....	33,563	5.8	97.2	11,415	5.1	96.4	10,635	18.8	91.6	3,217	1.8	99.6	7,880	15.0	94.8	356	0.5	99.8
1.25 to 1.49....	45,101	7.8	91.4	24,164	10.8	91.3	6,736	11.9	72.8	6,748	3.8	97.8	6,724	12.8	79.8	729	1.0	99.3
1.50 to 1.74....	78,102	13.4	83.6	36,865	16.5	80.5	7,804	13.8	60.9	23,316	13.1	91.0	8,861	16.9	67.0	1,226	1.7	98.3
1.75 to 1.99....	75,551	13.0	70.2	33,085	14.9	64.0	6,476	11.4	47.1	26,121	14.7	80.9	6,809	13.0	50.1	3,060	4.2	96.6
2.00 to 2.24....	110,689	19.0	57.2	39,579	17.8	49.1	7,106	12.6	35.7	50,901	28.7	66.2	7,473	14.2	37.1	5,640	7.8	92.4
2.25 to 2.49....	73,665	12.7	38.2	29,427	13.2	31.3	5,839	10.3	23.1	29,504	16.6	37.5	3,618	6.9	22.9	5,277	7.3	84.6
2.50 to 2.74....	52,837	9.1	25.5	15,464	6.9	18.1	3,221	5.7	12.8	18,113	10.2	20.9	4,738	9.0	16.0	11,291	15.6	77.3
2.75 to 2.99....	24,416	4.2	16.4	7,620	3.4	11.2	1,588	2.8	7.1	6,668	3.8	10.7	1,173	2.8	7.0	7,112	9.9	61.7
3.00 to 3.24....	31,577	5.4	12.2	6,133	2.8	7.8	1,257	2.2	4.3	5,942	3.3	6.9	1,709	3.3	4.2	16,496	22.8	51.8
3.25 to 3.49....	10,733	1.8	6.8	5,644	2.5	5.0	570	1.0	2.0	1,913	1.1	3.6	122	0.4	0.9	2,424	3.3	29.0
3.50 to 3.74....	20,324	3.5	5.0	3,631	1.6	2.5	164	0.3	1.0	3,201	1.8	2.5	113	0.2	0.5	13,225	18.3	25.7
3.75 to 3.99....	2,397	0.4	1.5	839	0.4	0.9	288	0.5	0.7	318	0.2	0.7	60	0.1	0.3	892	1.2	7.4
4.00 to 4.24....	4,214	0.7	1.1	367	0.2	0.5	57	0.1	0.2	348	0.2	0.5	58	0.1	0.2	3,381	4.7	6.2
4.25 and over.	2,317	0.4	0.4	671	0.3	0.3	43	0.1	0.1	487	0.3	0.3	49	0.1	0.1	1,067	1.5	1.5

(a) Less than one-tenth of 1 per cent.

As shown by the above table, rates were much higher in the Western division than in any of the others, 51.8 per cent of the wage-earners in that division receiving $3 per day or over. The three rate groups showing the greatest number of employees are as follows: $2.50 to $2.74, 15.6 per cent; $3 to $3.24, 22.8 per cent; and $3.50 to $3.74, 18.3 per cent. In this group of states are included almost all of the gold and silver and copper mines of the country.

The wages in the North Central division were considerably lower than those in the Western division, but higher than those in either of the three other divisions. The range of wages for the majority of the employees, 83.3 per cent, was from $1.50 to $2.74, the rate group showing the greatest number of wage-earners being that of $2 to $2.24, which includes 28.7 per cent of the total number. In this North Central division are included the iron mines of Michigan and Minnesota, the coal mines of Ohio, Indiana, and Illinois, and the oil wells of Ohio and Indiana.

The rates of pay in the North Atlantic division were only slightly lower than those in the North Central division. The bulk of the employees received between $1.25 and $2.49 per day, 73.2 per cent being included between those rates. Over 70 per cent of the wage-earners in this division were employed in the coal mines of Pennsylvania.

Wages were lowest in the South Atlantic and South Central divisions, there being very little difference between the two sections. In each section 78.8 per cent of the total number were included between the rates $1 and $2.49.

IX.

CONTRACT MINING AND QUARRYING.

By reference to the copy of that part of the schedule of inquiry which relates to employees and wages, shown in Appendix A, it will be seen that operators were required to report mining or quarrying which was paid for otherwise than by the day. The inquiry was made a part of the schedule in order to determine the conditions of employment of those engaged in the actual work of mining and the extent to which such work was done under other terms of payment than daily rates. To indicate the extent to which such work was done in the different kinds of mining, Tables 45 and 46 are shown. Table 45 gives the total average number of miners and miners' helpers, and quarrymen and stonecutters, with the amount paid in wages to this class of employees; also the average number of contract miners, with their wages and the percentage the number of contract miners forms of the total number of men engaged in mining and their wages form of the total wages, respectively.

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TABLE 45.—*Comparison of contract miners with all miners, by minerals: 1902.*

MINERAL.	MINERS AND MINERS' HELPERS AND QUARRYMEN AND STONECUTTERS.		CONTRACT MINERS AND QUARRYMEN.			
	Average number.	Wages.	Average number.	Per cent of all miners and quarrymen.	Wages.	Per cent of wages paid to all miners and quarrymen.
Total	343,166	$230,112,393	230,846	67.3	$155,578,988	67.6
Asbestos	17	8,703				
Asphaltum and bituminous rock	117	69,721	13	11.1	6,360	9.1
Barytes	322	125,829	229	71.1	96,549	76.7
Bauxite	77	24,269				
Borax	96	71,096				
Buhrstones and millstones	80	36,734	9	11.3	4,390	12.0
Cement	3,251	1,440,029	449	13.8	215,795	15.0
Clay	1,676	661,202	177	10.6	90,896	13.7
Coal, anthracite	24,688	18,007,868	22,629	91.7	16,572,582	92.0
Coal, bituminous	192,910	130,364,960	189,081	98.0	128,055,854	98.2
Copper ore	14,078	12,375,203	2,206	15.7	1,601,091	12.9
Corundum and emery	83	20,146				
Crystalline quartz	26	12,892				
Feldspar	183	77,543	16	8.7	7,065	9.1
Flint	65	27,648	18	27.7	8,519	30.8
Fluorspar	185	71,947				
Fuller's earth	54	17,140				
Garnet	61	29,506				
Gold and silver	23,030	22,776,625	357	1.6	381,796	1.7
Graphite	93	42,111				
Grindstones and pulpstones	118	54,270	28	23.7	11,757	21.7
Gypsum	614	319,606	166	27.0	85,976	26.9
Infusorial earth, tripoli, and pumice	23	9,172	1	4.3	650	7.1
Iron ore	20,849	11,963,312	8,105	38.9	5,090,832	42.6
Lead and zinc ore	3,958	2,142,748	2	[1]	260	[1]
Limestones and dolomites	22,096	10,250,084	3,772	17.1	1,482,678	14.5
Lithium ore	6	3,744				
Manganese ore	99	44,439				
Marble	2,513	1,418,332	17	0.7	6,600	0.5
Marl	10	8,919				
Mica	73	31,192				
Mineral pigments, crude	109	42,222	52	47.7	28,907	68.5
Monazite	86	24,728	65	75.6	19,280	78.0
Oilstones, whetstones, and scythe stones	71	31,667	1	1.4	230	0.7
Phosphate rock	4,292	1,335,979	1,180	27.5	288,003	21.6
Precious stones	84	69,828				
Quicksilver	840	553,207	104	12.4	67,000	12.1
Sandstones and quartzites	7,117	4,420,075	822	11.6	585,965	13.3
Silica sand	149	66,074	24	16.1	9,229	14.0
Siliceous crystalline rocks	14,474	8,665,190	528	3.6	321,626	3.7
Slate	3,656	2,155,865	800	21.9	491,325	22.8
Sulphur and pyrite	402	192,846	7	1.7	5,803	3.0
Talc and soapstone	428	147,184	5	1.2	1,229	0.8
Tungsten	2	1,200				
Uranium and vanadium	17	15,840				
All other minerals[2]	14	9,411	3	21.4	1,575	16.7

[1] Less than one-tenth of 1 per cent.
[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

It should be understood that the contract miners and quarrymen reported in the above table were not employees additional to those shown under wage-earners by classes, but are included there and also in the tables showing wage-earners by specified daily rates of pay and the average number employed during each month.

Of the total number, 343,166, engaged in actual mining aside from the other supplemental but necessary work about mines, such as timbering, track laying, operating engines and pumps, etc., 230,846, or 67.3 per cent, were paid by the amount of work done. They received in wages $155,578,988, or 67.6 per cent of the total wage payment.

It will be observed that the statistics for petroleum and natural gas are not shown in the foregoing table. In these industries the regular employees are almost entirely engaged in the maintenance and operation of the wells, and there are no employees that could be classified as "miners and miners' helpers or quarrymen and stonecutters." The initial work of developing oil and gas properties—drilling wells and building rigs—is practically all done by outside contractors, and the cost of such work is given in Table 47.

The following industries are those for which no contract mining was reported and in which payment for mining, in all cases, was by the day: Bauxite, borax, corundum and emery, crystalline quartz, fluorspar, fuller's earth, garnet, graphite, lithium ore, manganese ore, marl, mica, precious stones, tungsten, uranium and vanadium, magnesite, molybdenum, nickel and cobalt, and rutile.

In the coal industry practically all the employees who are engaged in cutting the coal and loading it into cars in the mine are paid by the car, ton, or yard. In bituminous coal mining 189,081 miners and miners' helpers, or 98 per cent of the total number of this class of workmen, were paid by the piece; in anthracite mining 22,629, or 91.7 per cent of the total for the industry, received wages by the piece. The amounts paid in the two industries were $128,055,854, or 98.2 per cent, and $16,572,582, or 92 per cent, respectively.

A feature of wage payment which distinguishes coal mining from other branches of the mining industry is the custom of "allowance," which obtains to a greater or less degree in nearly all coal mining operations. There are so many complex influences affecting the amount of payment to miners working by the ton, car, yard, or otherwise than by the day, that it is sometimes considered expedient and equitable to make payment for yardage—the number of linear yards which the "chamber," "heading," or "breast" in which the miner works may have been driven during the time for which payment is made, in addition to the earnings which may have accrued from the regular rate by the car or otherwise; also to make additional allowances in consideration of difficult mining, narrow work, or for other causes. This is done in order to equalize the earnings of the miners; otherwise it might frequently be the case that the harder working and in other respects more deserving employee would receive less pay than one whose output was smaller and hours of work fewer. While it may be customary to make similar allowances in other mining industries, it certainly can not be so to the same extent, and therefore no provision was made in the general mining schedule or in any of the other schedules, except for coal, for a separate report of such payments. The following table shows, for coal by states, the total amount paid in wages to contract miners and, in an adjoining column, the amount of such wages which was paid for yardage or other allowances and the percentage which the latter is of the total wages. The number of mines at which payment was reported by the ton, car, yard, or other unit is also given.

TABLE 46.—*Wages paid for contract coal mining, and amount paid in allowances, by states and territories: 1902.*

STATE OR TERRITORY.	Total wages paid for contract mining.	YARDAGE AND OTHER ALLOWANCES.		MINES REPORTING PAYMENT BY—			
		Amount paid.	Per cent of total wages for contract mining	Ton.	Car.	Yard.	Other unit.
United States	$144,628,436	$10,970,567	7.6	4,014	571	27	6
Alabama	5,867,310	600,383	10.2	103	7	......	......
Arkansas	1,150,822	150,206	13.1	47	......	......	......
California	18,003	......	......	2	......	......	......
Colorado	3,602,429	418,925	11.5	81	9	3	......
Illinois	17,930,485	1,233,139	6.9	640	6	8	......
Indian Territory	1,941,863	307,557	15.8	54	......	......	......
Indiana	5,225,804	450,158	8.6	259	7	......	......
Iowa	4,502,012	538,944	12.0	292	5	......	......
Kansas	3,488,067	540,345	15.5	146	......	......	......
Kentucky	2,927,064	251,247	8.6	150	1	3	......
Maryland	2,740,268	80,215	11.0	44	......	......	......
Michigan	853,896	182,940	21.4	31	......	......	......
Missouri	2,896,873	268,511	9.3	240	......	......	......
Montana	1,071,586	71,445	6.7	39	1	......	......
New Mexico	680,562	73,928	10.9	20	2	......	......
North Dakota	120,443	9,841	8.2	25	2	......	......
Ohio	12,026,317	830,[redacted]	6.9	554	33	2	1
Oregon	80,228	2,700	3.4	4	......	1	......
Pennsylvania, bituminous	44,284,860	2,010,075	4.5	921	50	1	4
Pennsylvania, anthracite	16,572,582	1,930,016	11.6	26	254	7	......
Tennessee	2,221,477	258,657	11.6	65	7	1	......
Texas	788,777	38,898	4.9	21	2	......	......
Utah	838,148	84,326	10.1	15	......	......	......
Virginia	856,999	23,866	2.8	3	14	......	......
Washington	1,415,687	42,530	3.0	3	7	1	......
West Virginia	8,623,329	430,936	5.0	247	161	......	1
Wyoming	1,892,869	194,888	10.1	22	3	......	......
All other states[1]	13,696	483	3.7	2	......	......	......

[1] Includes Idaho and North Carolina.

Table 46 shows that the amount paid for yardage or other allowances in coal mining, both anthracite and bituminous, was $10,970,567, which was 7.6 per cent of $144,628,436, the total amount paid for contract coal mining. The prevailing method of payment for contract coal mining in bituminous mines was by the ton, as there were 4,018 mines for which this method was reported, compared with 317 by the car, 20 by the yard, and 6 by other methods. The total number of mines reporting some method of contract mining was 4,648. The difference between this number and the total number of coal mines reported for the United States is 1,338, and is accounted for by the number of mines in which a daily rate of pay was the rule, and by the small "local coal banks" at which no wage-earners were employed. In several instances more than one of these methods was reported for the same mine. In anthracite coal mining, the prevailing method of payment was by the car, 254 mines reporting that method, as compared with 26 by the ton and 7 by the yard.

It should be stated that when payment by the yard is in the form of allowance only, it has not been included in Table 46 as a method of payment.

The subject of allowances in addition to the regular schedule of rates for coal mining receives the careful consideration of both the operators and the miners. The fact that 7.6 per cent of the wages paid for contract work was in the form of allowances indicates the prime importance of this feature of wage payment in the economical administration of the properties. Without this system no equitable and uniform scale of wages could be arranged.

These allowances are nearly always fixed by the foreman in charge of the mine, and usually result from a conference as to the equities of the case between him and the miner interested. It will be observed that according to Table 46 allowances were made in every state and territory separately shown, the amount ranging from $3,940,090 for both anthracite and bituminous in Pennsylvania to $2,700 in Oregon, and the percentage that the allowance is of the total wages paid for contract mining from 21.4 per cent in Michigan to 2.8 per cent in Virginia.

The schedule called for the rate of payment by the ton, car, yard, or otherwise, and a mass of information was received bearing upon this point. However, the very wide range of the rates and the complexities of the subject generally have defeated any statistical presentation of the data reported.

The amount paid for contract mining in the iron ore industry was $5,090,832, which was 42.8 per cent of the total amount paid to miners in that industry. The number of wage-earners so employed was 8,105, or 38.9 per cent of the total number of miners. Payment for contract mining in this industry was principally by the ton and by the tram, and occasionally by the yard, with a wide range of rates.

The number of contract wage-earners engaged in quarrying limestones and dolomites was 3,772, or 17.1 per cent of the total number of contract quarrymen and stonecutters, and the amount of wages paid was $1,482,678, or 14.5 per cent of the total for such work. The unit upon which payment was based was very irregular, as payment was reported by the tram, ton, foot, yard, perch, and bushel.

In gold and silver and lead and zinc mining the proportion of contract mining was very small and indicates that most of the work was done by the day. In lead and zinc mining contract mining was exceptional, as the amount reported was only $266. In those mines, however, where the landowner or first lessee was also the buyer of all ore mined by the sublessees, the latter were virtually wage-earners paid by the ton. The total number of such sublessees reported was 638 and the total amount paid to them was $244,661; out of this amount they were required to furnish their own supplies. In the tabulation of the statistics these sublessees in lead and zinc were regarded as proprietors and are not included in Table 46.

Contract mining was reported for only a small number of copper mines, and these were all in Michigan, no work of that kind being reported for the argentiferous copper mines of the Rocky mountain region. The average number of contract miners was 2,206, or 15.7 per cent of the total number, and the amount paid was $1,601,091, or 12.9 per cent of the total wages paid for mining copper ore. Drifting, as reported, was paid for by the foot, the rate ranging from $5.75 to $7.71. Stoping was paid for at an average of about $8 per cubic fathom.

In barytes mining 71.1 per cent of the miners worked by the piece system, and according to the reports, received payment by the ton, the rates ranging from $2 to $3.50.

Only a comparatively small percentage of cement-rock mining was done by contract. Payment in such cases was by the ton and there was a wide range of rates.

Contract clay mining was paid for by the ton, the rate ranging from 13½ to 75 cents per ton.

The rate paid for mining gypsum on contract ranged from 20 to 65 cents per ton, with most of the operators reporting a rate between 40 and 50 cents.

Thirteen and three-tenths per cent of the wages paid for quarrying sandstones and quartzites was for contract quarrying. The unit upon which payment was based in this industry was the same as in the quarrying of limestone and dolomites and siliceous crystalline rocks, very irregular, as payment was reported by the tram, ton, foot, yard, perch, and bushel, and the rates varied more widely.

A large proportion, 68.5 per cent, of the mining of crude mineral pigments was by the ton; the lowest rate reported was 40 cents and the highest $5 per ton.

Most of those engaged in monazite mining, while working independently of any proprietors, were reported as wage-earners on contract, as elsewhere described. The crude monazite obtained from the placers was sold by the miners at the rate of 4 cents per pound, and this was treated in the statistics as the rate received by them for contract mining.

Approximately one-fourth of the mining for phosphate rock was by contract. In a few instances payment was made by the car and yard, but in most cases it was by the ton. The rates ranged from 25 cents to $5 per ton. The latter amount was paid by an establishment in New Mexico, where the product was a bat deposit found in a cave and difficult and expensive to mine on account of its location.

Contract slate quarrying was by the square, and the lowest rate reported was 70 cents and the highest $2.25.

As shown by Table 45, there were several other industries for which small proportions of contract mining were reported, but the amount and percentage of the figures are comparatively unimportant.

X.

CONTRACT WORK.

In nearly all branches of the mining and quarrying industry occasions arise which demand considerable outlays for work that is different from the regular production of the ore or mineral—work such as tunneling, shaft sinking, boring test holes, and removing top earth where open-cut mining is intended—and this is frequently let to contractors who make a specialty of the work in question, usually to the lowest bidders. Table 47 shows for each mineral the value of the product, the amount paid for contract work and the number of employees engaged in it, and the per cent that the amount paid for this work is of the value of product.

TABLE 47.—*Comparison of contract work with value of product, by minerals: 1902.*

MINERAL.	Value of product.	CONTRACT WORK.		Per cent amount paid for contract work forms of value of product.
		Amount paid.	Number of employees	
Total	$796,826,417	$20,677,938	21,183	2.6
Asbestos	16,200			
Asphaltum and bituminous rock	236,728	10,060	60	4.2
Barytes	203,154	1,000	10	0.5
Bauxite	128,206	500	10	0.4
Borax	2,538,614			
Buhrstones and millstones	59,808			
Cement	21,268,338	10,627	34	(1)
Clay	2,061,072	13,241	36	0.6
Coal, anthracite	76,173,586	406,421	1,731	0.5
Coal, bituminous	290,858,483	1,244,114	5,040	0.4
Copper ore	51,178,096	188,768	195	0.4
Corundum and emery	104,605			
Crystalline quartz	13,085			
Feldspar	250,424			
Flint	144,209			
Fluorspar	275,682	300	3	0.1
Fuller's earth	98,144	4,021	8	4.1
Garnet	132,820			
Gold and silver	82,492,052	626,000	980	0.8
Graphite	227,508	900	2	0.4
Grindstones and pulpstones	667,431			
Gypsum	2,089,341	406	7	(1)
Infusorial earth, tripoli, and pumice	56,994			
Iron ore	65,465,321	425,292	1,079	0.6
Lead and zinc ore	14,600,177	108,607	223	0.7
Limestones and dolomites	30,441,801	36,381	137	0.1
Lithium ore	25,750			
Manganese ore	177,911			
Marble	5,044,182			
Marl	12,741			
Mica	118,849			
Mineral pigments, crude	300,885			
Monazite	64,160			
Natural gas	30,867,863	4,450,001	3,268	14.4
Oilstones, whetstones, and scythestones	113,968			
Petroleum	71,397,789	12,966,651	7,949	18.1
Phosphate rock	4,922,943	157,402	306	3.2
Precious stones	328,450			
Quicksilver	1,550,000	23,261	90	1.5
Sandstones and quartzites	10,601,171	500	1	(1)
Silica sand	421,299	100	2	(1)
Siliceous crystalline rocks	18,257,944			
Slate	5,696,051			
Sulphur and pyrite	947,089	3,587	15	0.4
Talc and soapstone	1,138,167			
Tungsten	5,975			
Uranium and vanadium	48,125			
All other minerals [2]	49,256	825	7	1.7

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[1] Less than one-tenth of 1 per cent.

[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt and rutile.

When the schedule of inquiry was drawn up the difficulty of obtaining complete and correct information in regard to contract work, especially concerning the number of men employed and the number of days required to complete the work, was fully appreciated by the officials of the Bureau of the Census and by experts who were consulted in the preparation of the schedule. It was believed that in most cases it would be impossible to locate the contractors. Generally no record is kept by the mine operators of any other data relating to contract work than the amount paid. The number of employees and the duration of the contract are matters of less concern to them. However, it was thought that the close attention they are obliged to pay to the work during its progress to insure strict compliance with the terms and specifications of the contract, would enable them, in the absence of records, to make a fair estimate of the data. This was realized in the course of the canvass, and the statistics are published with no pretentions that they can be regarded as strictly correct, but under the conviction that they are reasonably accurate considered as statistics which are in part estimated.

The employees reported under this inquiry are not included among the wage-earners and should not be considered as forming a part of the wage-earners reported by classes, and at specified daily rates of pay, nor of the average number reported for each month. No conclusions can be drawn from Table 47 as to the amount paid to contract employees, nor in regard to the average number for the entire year. As to the latter, indeed it is quite possible that some of the employees are duplicated in the figures.

The amount paid represents the entire cost of the contract work, including the wages paid, the cost of all supplies and materials used, other miscellaneous expenses, and the profits of the contractors. These expenses vary in their proportion to the whole cost according to the kind of work. In drilling wells for petroleum and natural gas, as a rule the cost of materials is greater in proportion than in any other description of contract work. The drilling carries with it the obligation to provide casing, tools, and all other supplies required to equip the wells; and in building the rig, all materials are generally furnished by the contractor. In shaft sinking, also, materials and supplies such as timber and explosives form a considerable proportion of the whole cost.

While no particular statistical value can be attached to a comparison of the cost of contract work with the value of product, yet always keeping in mind the fact that the figures are not fully representative of this class of work, a great deal of it being done by the regular employees of the mining companies, the table will serve to show the proportions of both with respect to the value involved.

Table 47 shows that the amounts paid for contract work and the percentages that these form of the value of the product are greater in the case of petroleum and natural gas than for any other mineral. In the crude-oil and natural-gas industry practically all of the development work, prospecting, and equipment of the properties are done by contract, which explains the large amount expended for such work. The regular employees of the producing companies are nearly all engaged in the maintenance and operation of the wells. The number of employees reported as employed on contract work in this industry approaches more nearly the true average number for the year than in any other.

As explained on page 20 of this report, the Standard Oil Company made reports covering the entire production of crude petroleum, with the exception of a few producers of heavy oil, in Pennsylvania, New York, Ohio, West Virginia, and Indiana, and combined reports of its own production for Kentucky and Kansas, without separating the production by counties, as was generally required by the Bureau of the Census. Also, for natural gas the company reported for its subsidiary or contributary companies the production in Pennsylvania, New York, Ohio, and West Virginia, making a single report for each state. In reporting contract work the amount paid was given, but it was stated that the number of men employed could not be given, and in lieu of exact information the average number of men required for each well and rig and the average time required to complete the work at each well were reported. From these data, using as a basis the number of wells drilled during the year and assuming that operations were continued throughout the whole year on full time, the average number of men employed was computed. While the figures, therefore, are pure estimates, if the information furnished by the company is accurate they may be accepted as fairly representing the statistics for this branch of the industry. Taking into consideration the fact that the amount paid for contract work in the petroleum and natural-gas industries, $17,415,632, is 84.2 per cent of the total paid in all mining and quarrying industries, $20,677,938, and that the number of employees in these industries, 11,217, is 53 per cent of the total, 21,183—with the additional consideration of the great preponderance of the Standard Oil Company's interests over those of all other oil producers—an idea is obtained of the extent to which the total number of employees engaged in contract work in all the industries is affected by the estimates which were made necessary.

The amount paid for contract work in coal mining was $1,650,535; in anthracite $406,421, and in bituminous $1,244,114; and the number of employees was 6,771—in the former 1,731, and in the latter 5,040. The information was generally reported by the coal operators very completely. No reduction of the number of employees reported to the average number for the year was made, and the number given in the table may contain duplications, as there was nothing in the reports to show whether or not a force of employees engaged in a contract and so reported was not again reported for another contract, taken after the completion of the first for a different operator and both during the census year 1902. Unlike those engaged in deep mining for the precious metals—for copper, iron, etc.—coal miners, engaged as they are in mining a material more easily worked than the surrounding rock and which is always found in well-defined veins, are usually unsuited for what is termed "rock work." Therefore such work as tunneling, shaft sinking, boring test holes, etc., is in most cases done more economically under the contract system. The larger companies, however, frequently maintain a force of men especially for that purpose.

The amount reported as paid for contract work in gold and silver mining was $626,090, which was only eight-tenths of 1 per cent of the value of the product of the mines. The work was very similar to development work in other kinds of mining. In some cases, where considerable depth had been reached and pumping had to be done on an extensive scale, it was at times impossible for one mining company to pump the water from its mine without at the same time clearing all adjacent mines. This work was therefore most conveniently done by contracting firms or companies with whom the business had become a specialty.

The amount paid for contract work in iron ore mining was $425,292, and there were 1,079 men employed. The work was similar in character to that done in other branches of the mining industry, except that there may have been a larger proportion of stripping preparatory to open-cut mining.

It should be explained that in the data shown in Table 47, in addition to the amount paid for work other than mining which was done by contract, there is included the amount paid by private operators to state and municipal penal institutions for the lease or use of convicts in the operation of mines and quarries. A careful examination of the reports received shows that $530,341 was paid for this purpose. The laws of certain Southern states permit the lease of convicted prisoners to private persons or firms for work outside of the penitentiaries. Among the states by which this is done are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, and Tennessee. This is entirely apart from the work of convicts in mines or quarries owned by the state. The only states in which the convicts were reported to have been leased to work in mines and quarries, and to which the amount above reported, $530,341, was paid, are the following: Alabama, coal; Florida, phosphate rock; Georgia, coal and iron ore; North Carolina, limestone.

In addition to the contract work shown in Table 47, a large amount of such work was done at mines and quarries which did not produce any mineral in 1902, but at which development work of some kind was done. The amount paid and the number of employees engaged in contract work at idle mines or those in process of development are shown, by minerals, in the following table:

TABLE 48.—*Contract work at nonproducing mines, by minerals: 1902.*

MINERAL.	Amount paid.	Number of employees.
Total	$2,664,526	7,019
Borax	500	3
Coal, bituminous	33,767	135
Copper ore	200	1
Gold and silver	1,542,771	5,649
Iron ore	216,168	296
Lead and zinc ore	8,149	17
Manganese ore	158	1
Natural gas	104,239	173
Petroleum	758,433	758
Quicksilver	150	1

Adding the amount paid and the number of employees given in the above table to the corresponding data shown in Table 47 makes a total for the United States of $23,342,464 paid for contract work in 1902 at all classes of mines and 28,202 employees. Contract work was reported in greatest amounts from petroleum and natural-gas wells among productive properties; the largest amount of contract work at mines for which no production was reported was in the development and improvement of gold and silver mines. Petroleum and natural gas, iron ore, and bituminous coal follow in the order named.

XI.

PRODUCTION WITHOUT EMPLOYEES.

Speaking broadly, it required the services of 619,856 wage-earners and salaried employees, to whom was paid $408,980,512 to produce in 1902 the mineral product of the United States, which was valued at $796,826,417.

The conditions of mining and quarrying were such as to call for the employment of at least one person at a very large proportion of the plants, and in some branches of the industry the investment of capital in buildings and mechanical and other equipment and the organization of the working force were equal to those features of industrial organization in the largest and most important manufacturing establishments. On the other hand, in certain branches of the industry operations were conducted at many mines and quarries under conditions of the greatest simplicity with no hired labor and no mechanical equipment, with the exception of a few tools. Table 49 presents for each mineral the number of mines or quarries at which there were no employees, the proprietor doing all the work; also the value of the output of such establishments, and in adjoining columns, for purposes of comparison, the total number of mines and quarries and the value of their product with the percentage that the product of the class reporting no employees forms of the total.

TABLE 49.—*Production without employees, by minerals: 1902.*

MINERAL.	Total number of mines, quarries, and wells.	Number of mines, quarries, and wells without employees.	PRODUCT.		
			Total value for all mines, quarries, and wells.	Value for mines, quarries, and wells without employees.	Per cent of total value.
Total	151,516	4,368	$796,826,417	$1,816,650	0.2
Asbestos	4	1	46,200	200	0.4
Asphaltum and bituminous rock	24	4	235,728	23,000	9.7
Barytes	49	1	203,154	20	(1)
Bauxite	38	1	128,206	75	0.1
Borax	6		2,388,614		
Buhrstones and millstones	29	3	59,808	862	1.4
Cement	101		24,268,338		
Clay	205	31	2,061,072	13,866	0.7
Coal, anthracite	334		76,173,586		
Coal, bituminous	5,052	290	290,858,483	70,290	(1)
Copper ore	144	1	51,178,036	3,075	(1)
Corundum and emery	5		104,605		
Crystalline quartz	6		43,085		
Feldspar	27		250,421		
Flint	19		144,209		
Fluorspar	22		275,682		
Fuller's earth	4		98,144		
Garnet	7		132,820		
Gold and silver	2,992	599	82,482,052	482,011	0.6
Graphite	28		227,508		
Grindstones and pulpstones	9		667,431		
Gypsum	62	1	2,089,341	75	(1)
Infusorial earth, tripoli, and pumice	11	1	55,994	5,720	10.2
Iron ore	525	27	65,465,321	13,572	(1)
Lead and zinc ore	559		14,600,177		
Limestones and dolomites	3,246	975	30,441,801	237,294	0.8
Lithium ore	6		25,750		
Manganese ore	12	9	177,911	4,795	2.7
Marble	83	1	5,044,182	300	(1)
Marl	11		12,741		
Mica	49	18	118,849	18,438	15.5
Mineral pigments, crude	35	2	360,885	2,450	0.7
Monazite	23	14	64,160	1,776	2.8
Natural gas	15,806	1,755	30,867,863	615,251	2.0
Oilstones, whetstones, and scythestones	15		113,968		
Petroleum	118,671	266	71,397,739	148,327	0.2
Phosphate rock	115	1	4,922,943	400	(1)
Precious stones	46	[2]2	328,450	71,510	21.8
Quicksilver	41	3	1,550,090	1,871	0.1
Sandstones and quartzites	1,304	296	10,601,171	65,871	0.6
Silica sand	26		121,289		
Siliceous crystalline rocks	906	68	18,257,944	28,186	0.2
Slate	199	4	5,696,051	1,316	(1)
Sulphur and pyrite	23	1	947,089	80	(1)
Talc and soapstone	20		1,138,167		
Tungsten	4	1	5,975	234	3.9
Uranium and vanadium	3	2	48,125	5,125	10.6
All other minerals[3]	6		49,256		

[1] Less than one-tenth of 1 per cent.

[2] Includes value of product of 456 operators for whom no mines were reported.

[3] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

The practice of operating mines by the owner or lessee without the employment of labor is more prevalent in some mining industries than in others, and necessarily affects the relative proportion which the number of employees bears to the quantity of product for the industry considered as a whole and in its several branches. Of the total number of mines, quarries, and wells (151,516) there were only 4,368, or 2.9 per cent, at which all the work was done by the proprietors, and the value of the products of such mines, quarries, and wells was only $1,816,650, or 0.2 per cent of $796,826,417, the total for the United States for all mining industries. At the census of manufactures, of the total number of manufacturing establishments (512,254) there were 110,510, or 21.6 per cent, in which the work was done by the proprietors without hired assistance.

The industries in which there was one employee or more reported at every plant are as follows: Borax, cement, coal, anthracite; corundum and emery, crystalline quartz, feldspar, flint, fluorspar, fuller's earth, garnet, graphite, grindstones and pulpstones, lead and zinc ore, lithium ore, marl; oilstones, whetstones, and scythestones; silica sand, sulphur and pyrite, talc and soapstone, chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Precious stones show the highest percentage for the value of the product obtained without employees, 21.8 per cent; this is accounted for by the fact that a value amounting to $69,550 was, as elsewhere explained, the result of accidental discoveries by individuals and not of systematic and regular mining. The other high percentages were for mica, 15.5; for uranium and vanadium, 10.6; for infusorial earth, tripoli, and pumice, 10.2; and 9.7 for asphaltum and bituminous rock. Less than one-tenth of 1 per cent of the product of bituminous coal mines was from mines without employees.

The statistics for petroleum and natural-gas wells are misleading and are not in the least representative of conditions as to the employment of wage-earners at the well. The percentage of the product of wells without employees as it appears in the table was 2 for both petroleum and natural gas. It is unquestionable that a much larger number of wells were operated and a larger output produced under conditions requiring no employees than the table indicates. The circumstances surrounding the reports of the Standard Oil Company, as previously explained, are accountable for the evident inaccuracy of the figures. Separate reports were not furnished by this company for the different groups of wells under its ownership or control, or for the wells in different counties, but the reports were made by states, the report for a state including all oil or gas operations in that state; it was, therefore, obviously impossible to determine from the reports whether or not particular wells or groups of wells required hired labor for their operation.

XII.

IRREGULAR PRODUCERS.

A large proportion of the mining and quarrying done in this country is of a regular and stable character, and there was no great difficulty encountered in securing complete Census reports from most of the operators of this class. There are, however, in some branches of mining and quarrying irregular producers who operate independently, working at such times as they feel inclined or only enough to obtain a product sufficient to satisfy the local demand. Some of these small operators work the same digging from time to time, while others, such as the placer gold and monazite miners, work in different localities, selected with reference to the richness of the deposits. It was found to be impossible to secure Census reports from all operators of this class, but the necessary information was sometimes obtained from merchants who purchased the products, or from others.

This condition was exemplified in the monazite industry of North Carolina. The industry is one of placer mining, and is carried on in many instances irregularly by men whose expenses are sometimes advanced by the operators of a concentrating plant, who purchase their production, and from whom—as it was found impossible to obtain reports from the miners themselves—the report was obtained covering the operations of all. The men thus irregularly engaged in monazite mining are not employees or wage-earners, strictly speaking, but it was considered that they should be so treated in the statistics. Several hundred were reported as so employed, but by the method of reduction to the average for the entire year this number was very greatly reduced. The amount paid for the crude monazite at the concentrator was treated as the wages of these miners.

Somewhat similar conditions existed in the manner in which the operations were conducted in placer mining for gold. The mines were quite generally found in localities remote from settled communities and difficult to reach on that account, and partly for this reason the special agents engaged in making the canvass were instructed not to secure reports from placer mines at which less than two wage-earners were employed. This has resulted in the omission from the statistics of about one-fourth of the placer mines. Unlike the method followed in the treatment of statistics of monazite, no cognizance has been taken in the statistics, either by estimate or otherwise, of the operations thus omitted.

Again, in 1902, a large proportion of the output of precious stones was the result of work that was not open to statistical treatment as to capital, employees and wages, expenses, etc. The entire value of this product for the United States was $328,450, of which $69,550, or 21.2 per cent, was the value of different varieties of precious stones that were yielded not by systematic mining operations, but by accidental discovery here and there in the search for other minerals. For this part of the production, therefore, statistics for value of product alone are presented.

In bituminous coal mining there was a large number of mines which are classed as "local" mines or "farmers' coal banks," which were operated only to supply the needs of the neighborhood in which they were located. The number of such mines as reported at the Eleventh Census was 9,969, as compared with 826 reported at the census of 1902. The difference in the numbers reported at the two censuses is due largely, if not entirely, to the failure to reach all of these unimportant mines in 1902. According to the returns received from such mines, wage-earners were employed to but a limited extent and only for short periods, and when the total number was reduced to an average for the year, the result was a very insignificant number as compared with the total number of wage-earners employed in the industry.

XIII.

TIME IN OPERATION.

Table 50 shows the number of mines, quarries, and wells classified according to time in operation by periods of thirty days, by the number of shifts per day, and by the number of hours in a shift, from six to twelve. The number of mines for which the information was not reported also appears.

TABLE 50.—TIME IN OPERATION: 1902.

MINERAL	NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO DAYS IN OPERATION.													
	Total	30 and less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 365.	Not reported.
Total	151,516	1,298	1,362	1,110	1,464	1,464	1,336	1,913	1,764	1,835	3,794	117,308	15,090	1,778
Asbestos	4	1		2							1			
Asphaltum and bituminous rock	24	2	2	2	1	1	1	1	3		5		1	5
Barytes	49	4	2	3	7	2		16	2	5	6			2
Bauxite	38					5	1	1			30			1
Borax	6							2			4			
Buhrstones and millstones	29	2	5	1	2		1	3	3	3	4	2		
Cement	101	3	3	3	5	3	3	9	7	18	28	13	6	
Clay	205	10	11	9	11	10	20	15	14	24	54	10		17
Coal, anthracite	334	7	13	19	54	111	89	25	9	2	2	1		2
Coal, bituminous	5,652	337	356	304	427	439	468	801	841	755	736	136	17	35
Copper ore	141	3	1	9	4	9	11	11	3	5	11	40	31	3
Corundum and emery	5		1			1					2		1	
Crystalline quartz	6					2	1				3			
Feldspar	27	4		2	2	5	1	2		2	8	1		
Flint	19		3	4	1		2	1	1	2	4	1		
Fluorspar	22		1		4	2		1	4	4	6			
Fuller's earth	4				1						2	1		
Garnet	7		1	1				1	1		2			1
Gold and silver	2,992	100	219	221	255	203	199	171	132	129	301	178	462	422
Graphite	28		3	11		2	1	3	1	4	2	1		
Grindstones and pulpstones	9				1	2		2	1		2		1	
Gypsum	62	2	4	4	4	2	4	3	3	6	25	3	2	
Infusorial earth, tripoli, and pumice	11	1			1	3		1			3			2
Iron ore	525	19	23	22	18	28	21	40	50	39	120	103	26	16
Lead and zinc ore	529	26	14	40	58	44	32	55	50	59	105	35	7	4
Limestones and dolomites	3,246	569	344	200	257	215	203	251	221	217	353	65	33	318
Lithium ore	3		1	1	1									
Manganese ore	19	3	1	1	2		1	1			2		1	7
Marble	83		4	4	1	4	4	8	7	5	33	11	1	1
Marl	11	3	3	1	2			1		1				
Mica	49	2	6	5	3	5	3	11	4		3			7
Mineral pigments, crude	35		4	1	5	5	2	1		4	7	4		2
Monazite	23	6	6	2	1	1	1	3	1		2			
Natural gas	15,806	19	33	39	79	108	41	72	31	198	1,118	1,858	11,898	312
Oilstones, whetstones, and scythestones	15	3		1	2	1		1		2	4	1		
Petroleum	118,671	57	115	71	93	101	74	122	90	58	446	114,753	2,581	107
Phosphate rock	115	1	8	5	4	5	1	7	13	15	46	8		2
Precious stones	46	1	1	1	8			2	19	10			3	1
Quicksilver	41				5		1		2	1	5	9	16	2
Sandstones and quartzites	1,304	77	85	56	88	78	62	119	84	72	98	19	2	466
Silica sand	26		1	2	1	3		2	4	3	7			3
Siliceous crystalline rocks	906	29	47	53	43	63	76	130	117	131	160	37	1	19
Slate	199	2	6	3	7	1	9	15	44	58	31	7		16
Sulphur and pyrite	23				1		2	2	1		6	7		4
Talc and soapstone	20	1			3	1	1	1	1	2	6	4		
Tungsten	4	1	2		1									
Uranium and vanadium	3	1			1					1				
All other minerals[1]	6	2		1		1					1			1

[1] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

TABLE 50.—TIME IN OPERATION: 1902—Continued.

MINERAL.	NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO SHIFTS PER DAY.[1]				NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO HOURS PER SHIFT.[2]							
	1.	2.	3.	Not reported.	6.	7.	8.	9.	10.	11.	12.	Not reported.
Total	20,873	128,406	212	2,025	81	86	4,628	2,685	13,604	210	128,185	2,034
Asbestos	4							1	3			
Asphaltum and bituminous rock	17		2	5			4		15			5
Barytes	47			2			11	13	23			2
Bauxite	39	1		1					39		1	1
Borax	4	1	1				1		5			
Buhrstones and millstones	26							3	23			
Cement	55	45	1				3	1	54	2	41	
Clay	185	3		17			32	21	130		5	17
Coal, anthracite	328	4		2		5	42	75	210			2
Coal, bituminous	5,527	90		35	12	39	2,729	872	1,951	5	9	35
Copper ore	54	66	19	5			16	50	70		3	5
Corundum and emery	5						1		4			
Crystalline quartz	6								6			
Feldspar	27							4	23			
Flint	19						1	2	16			
Fluorspar	21	1							22			
Fuller's earth	3	1							4			
Garnet	5	1		1					5		1	1
Gold and silver	1,778	638	158	418	1	9	915	393	1,099	9	136	427
Graphite	26	2					1	6	20		1	
Grindstones and pulpstones	9								9			
Gypsum	57	5					2	1	56	1	2	
Infusorial earth, tripoli, and pumice	8	1		2					8		1	2
Iron ore	356	140	12	17	1	1	28	9	451	14	4	17
Lead and zinc ore	480	70	5	4			148	325	76		10	4
Limestones and dolomites	2,898	28	2	318	1	2	115	142	2,624	15	29	318
Lithium ore	3						1	1	1			
Manganese ore	11	1		7			1		11			7
Marble	81	1		1			3	4	75			1
Marl	11								11			
Mica	41	1		7			4	12	26			7
Mineral pigments, crude	31	2		2				2	30		1	2
Monazite	23							2	21			
Natural gas	3,939	11,308		559	12	2	32	169	3,555		11,477	559
Oilstones, whetstones, and scythestones	15							2	13			
Petroleum	2,595	115,962	6	108	51	27	221	53	1,627	130	116,454	108
Phosphate rock	108	5		2				2	81	24	6	2
Precious stones	44	1		1			2	33	10			1
Quicksilver	23	11	5	2			6	6	27			2
Sandstones and quartzites	836	2		466	3	1	39	133	661	1		466
Silica sand	23			3					23			3
Siliceous crystalline rocks	887			19			186	355	341	5		19
Slate	182	1		16				42	139	2		16
Sulphur and pyrite	11	7	1	4			2	2	14		1	4
Talc and soapstone	14	6						2	14	2	2	
Tungsten	4						3	1				
Uranium and vanadium	3						3					
All others minerals[3]	4	1		1			1	2	1		1	1

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[1] Duplication of 33 mines which reported more than one class of shifts per day, distributed as follows: Colorado, 13; California, 11; Idaho, 5; Oregon, 2; South Dakota, 1; Texas, 1; Utah, 1.

[2] Duplication of 34 mines which reported more than one number of "hours per shift," distributed as follows: Colorado, 4; California, 20; Idaho, 3; Montana, 1; Nevada, 1; Oregon, 4; Texas, 1.

[3] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

At many of the mines and quarries work was extremely irregular on account of fluctuating demands and the interruption of operations by seasonal changes.

From the totals for all minerals it appears that a large majority of the mines, quarries, and wells in the United States worked full time throughout the year, or from 301 to 365 days, with two shifts of 12 hours each per day; but this is caused by the fact that nearly all of the natural-gas and petroleum wells were in constant operation both day and night for periods exceeding 300 days. If the statistics for these wells are omitted, it will be seen that one shift of 10 hours was the most general plan, with the 8-hour day next in importance.

When the figures for petroleum and natural-gas wells are deducted from the totals for all minerals a total of 17,039 mines and quarries is obtained; of this number 14,339 worked one shift, 1,136 worked two shifts, 206 were operated by three shifts, and for 1,391 the information was not reported. The shift was 10 hours in length at 8,422 mines, 8 hours at 4,375, 9 hours at 2,463, and 12 hours at 254, and for 1,367 the information was not reported.

The larger number of anthracite coal mines were in operation from 91 to 210 days. This comparatively short period of operation was, as elsewhere explained, due to a strike in that industry. Of the total number of mines, 328 were operated by only one shift per day, which appeared to be the rule; the length of the shift was quite generally 10 hours.

The bituminous coal mines seem to be quite evenly distributed as to the number of days in operation, a large number appearing in each group from 30 days and less in those which exceeded 300 days. The larger number, however (3,133), were reported as operating for periods from 181 days to 300 days. One shift of 8 hours appears to have been the general custom.

In copper mining the mines working two shifts were more numerous than those working one, and a considerable proportion of gold and silver and iron ore mines worked more than one shift per day.

The statistics show that a very large proportion of natural-gas and petroleum wells were in operation from 301 to 365 days, working two shifts of 12 hours each per day.

The stone quarries, including marble, limestones and dolomites, sandstones and quartzites, siliceous crystalline rocks, and slate, according to the table, with comparatively few exceptions, worked but one shift per day. The larger proportion were reported as working 10 hours per shift, although a considerable number reported 8 and 9 hour shifts.

XIV.

MISCELLANEOUS EXPENSES.

An inquiry concerning miscellaneous expenses was first included in the schedules at the census of 1890, when the "total of all other expenditures in the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.)" was reported as a separate item. The same inquiry at the census of 1902 required separate amounts to be reported for (1) royalties and rent of mine and mining plant, and (2) amount paid for rent of office, taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere. In the special schedule for gold, silver, lead, and copper mines, these amounts were further itemized as follows: (1) Amount expended in development work; (2) rent and royalties of mine and mineral land; (3) rent of mining plant and improvements; (4) rent or royalty for tunnel privileges; (5) water rent; (6) other rent or royalties; (7) amount paid for taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere.

Of the total amount paid as miscellaneous expenses, $47,805,681, or 66.6 per cent, was reported by mine operators engaged in the production of fuels, and $17,168,321, or 23.9 per cent, for the metallic group, leaving only $6,797,711, or 9.5 per cent, for all other minerals.

The amounts reported in answer to the several inquiries are shown in detail in the reports for the different minerals. The miscellaneous expenses reported for all minerals amounted to $71,771,713, of which sum $34,530,713, or 48.1 per cent, was paid as royalties and rent of mines and mining plants. Royalties and rent form the most important single item included in the group of miscellaneous expenses, and, with the exception of salaries, wages, and supplies and materials, is the most important item of expenditure reported for mining operations. Of the total ($625,245,130) reported as expenses—salaries and wages amounted to $408,980,512, or 65.4 per cent; supplies and materials to $123,814,967, or 19.8 per cent; miscellaneous expenses to $71,771,713, or 11.5 per cent; and contract work to $20,677,938, or 3.3 per cent. Table 51 shows the amount of miscellaneous expenses reported for the different groups of minerals and the percentage that the totals for each group are of the total for all minerals.

TABLE 51.—*Miscellaneous expenses, by groups of minerals and percentage each group is of total: 1902.*

GROUP.	TOTAL.		ROYALTIES AND RENT OF MINE AND MINING PLANT.		RENT OF OFFICES, TAXES, INSURANCE, ETC.	
	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All minerals	$71,771,713	100.0	$34,530,713	100.0	$37,241,000	100.0
Metallic	17,168,321	23.9	9,591,964	27.8	7,576,357	20.3
Fuels	47,805,681	66.6	23,264,925	67.4	24,540,756	65.9
Structural materials	5,750,482	8.0	1,260,673	3.6	4,489,809	12.1
Abrasive materials	42,410	0.1	8,421	(1)	33,989	0.1
Chemical materials	741,570	1.0	296,410	0.9	445,160	1.2
Pigments	30,448	0.1	10,626	0.1	19,822	(1)
Miscellaneous	202,801	0.3	67,693	0.2	135,108	0.4

[1] Less than one-tenth of 1 per cent.

No analysis is possible of the amounts paid for rent of offices, taxes, insurance, etc., although these expenditures form the larger proportion of the miscellaneous expenses reported for a number of the minerals.

Royalties and rent.—Payments for the use of mineral lands are either in the form of a rental of a fixed amount or are made as percentages of the quantity of mineral extracted or of the value of the metal recovered. The importance of royalties and rent is indicated by the fact that in the total for all minerals it forms 4.3 per cent of the value of the products; in the metallic group, 4.5 per cent; in the fuels, 5 per cent; and in the other groups of minerals from seven-tenths of 1 per cent to 7.2 per cent of the value of the products. The largest amounts are paid as royalties and rent in the production of fuels, the expenditure forming an important item of the total cost. In the production of coal the royalty is usually specified in the contracts with the landowners and is generally a certain rate per ton of coal raised. The variation in the amount of royalty paid per ton in the production of anthracite coal is shown in the following table, which gives the number of operators paying each rate:

TABLE 52.—*Coal, anthracite—number of operators at various rates of royalty: 1902.*

RATE PER TON (CENTS).	Number of operators paying each rate.	RATE PER TON (CENTS).	Number of operators paying each rate.	RATE PER TON (CENTS).	Number of operators paying each rate.
0.3	1	15.0	9	30.6	1
0.6	1	15.9	1	31.0	1
0.7	1	16.0	2	32.0	4
1.0	1	16.7	1	32.1	1
1.1	1	16.8	1	32.3	1
2.0	2	17.7	1	32.8	1
2.7	1	17.8	1	33.0	3
3.0	1	18.0	4	33.1	1
3.1	1	18.7	1	33.2	1
4.0	2	20.0	12	33.8	1
4.5	1	20.3	1	35.0	18
5.0	14	21.0	1	36.0	4
5.5	1	22.0	2	37.0	2
6.0	3	22.1	1	37.5	1
6.2	2	22.5	1	38.0	2
6.3	2	23.0	3	39.7	1
7.0	2	23.5	1	40.0	10
7.1	1	24.0	2	41.0	1
7.8	1	25.0	20	44.0	1
8.0	3	26.0	4	45.0	1
8.8	1	26.5	1	46.0	2
9.0	2	26.8	1	46.6	1
10.0	16	27.0	2	47.0	1
10.3	1	27.2	1	47.5	1
11.0	1	27.3	1	49.0	2
12.0	1	28.0	3	50.0	5
12.2	1	28.3	1	53.0	1
12.5	3	28.4	1	60.0	1
13.0	1	29.0	2		
14.9	1	30.0	13		

Of the 119 operators reporting for the production of anthracite coal, 84 reported the payment of royalties varying from three-tenths of 1 cent to 60 cents per ton. The most common rates of royalty were 5 cents per ton and multiples of that amount; 14 operators reported royalty payments of 5 cents per ton; 16, of 10 cents; 9, of 15 cents; 12, of 20 cents; 20, of 25 cents; 13, of 30 cents; 18, of 35 cents; and 10, of 40 cents. A number of mine operators reported different rates of royalty, each depending upon the terms of the contract with the individual owning the land. As large quantities of coal are mined from land owned by the operators, the amount of royalty paid has no relation to the value of the product reported for all mines.

The following table shows the number of bituminous coal operators reporting royalties at the rates specified:

TABLE 53.—COAL, BITUMINOUS—NUMBER OF OPERATORS IN EACH STATE AT VARIOUS RATES OF ROYALTY: 1902.

RATE PER TON (CENTS).	United States.	Colorado.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Missouri.	Ohio.	Pennsylvania.	West Virginia.	All other states.[1]
0.8	2							1		1		
1.0	3									1	1	1
1.3	3		2							1		
1.5	7		6				1					
1.6	1			1								
1.8	1		1									
2.0	16		5	8					2	1		
2.3	3		2	1								
2.4	1										1	
2.5	25		9	8			1	2		4		1
2.6	1			1								
2.7	1		1									
3.0	79		29	21	1		1	3	5	16	1	2
3.1	19		10	3	1		4	1				
3.3	1		1									
3.5	22		8	7	1				4	2		
3.6	1			1								
3.7	2			1				1				
3.8	4		1	2						1		
4.0	69		15	7	4		3	13	16	6	3	2
4.1	1										1	
4.2	4		3		1							
4.3	2						2					
4.4	1						1					
4.5	9		1	1			2		3		1	1
4.7	5		3	1	1							
4.8	2			1					1			
4.9	2		2									
5.0	244		25	21	24	3	4	11	33	69	28	26
5.3	4				1		1		1		1	
5.4	1										1	
5.5	12		2	3			1	1	2	2	1	
5.8	3						2		1			
6.0	143	3	9	6	4	8	5	6	36	32	24	10
6.2	1					1						
6.3	144		37	4	42	11	8	25	8	4	1	4
6.5	24		4	2	2	1	1	2	4	5	3	
6.7	1									1		
6.8	3			1	1				1			
7.0	122	3	8	5	7	4	2		14	32	15	32
7.3	2									2		
7.5	39	2	6		2		2	5	12	5	1	1
7.6	1											1
8.0	208	4		5	4	16	1	8	37	68	23	42
8.1	1										1	
8.3	20	2	11	1	3		1	1			1	
8.4	1									1		
8.5	7				1		1			2	2	1
8.6	1			1								
8.7	1								1			
8.8	2				1				1			
9.0	33		5	2	1	2		1	3	13	3	3
9.4	1						1					
9.5	2		1							1		
10.0	403	9	26	18	22	18	12	6	[illegible]	97	98	58
10.1	1										1	
10.5	1				1							
10.6	1			1								
11.0	8		1		1				4	1	1	
11.1	1		1									
11.3	4		1	1					2			
11.5	1		1									
11.8	1											1
12.0	46		12	3	1	6			13	7	1	3
12.3	1							1				
12.5	254	8	73	15	47	9	3	32	26	4	13	21
12.6	1								1			
13.0	12	1			3	2			2	3	1	
13.5	5		1							4		
14.0	4		1		1					2		
14.2	2		1		1							
15.0	83	4	17		10	1		2	20	11	6	12
15.3	1				1							
15.6	1										1	
16.0	8			1		1		2	1	1		2
16.5	1		1									
17.0	4				1	1				1	1	
17.5	2									1		1
18.0	9		4						1			4
18.5	1		1									
18.8	10		3	3	2	1			1			
19.0	2		1							1		
20.0	28	2	4	1	1	2	1		8	3	2	4
23.0	1								1			
25.0	77	8	15	5	16	4	2	7	4	3	1	12
26.3	1									1		
27.0	1								1			
30.0	7	1			1	1			1			3
31.3	1				1							
33.5	1									1		
35.0	1	1										
37.5	1				1							
38.0	1									1		
40.0	1								1			
50.0	4	1			1							2
57.0	1											1
150.0	1											1

Of the 4,409 operators engaged in the production of bituminous coal, 2,130, or 48.3 per cent, reported the payment of royalties varying from eight-tenths of 1 cent to $1.50 per ton. The rates most commonly reported were from 5 to 15 cents per ton, there being 1,850 operators paying royalties coming within these amounts.

The amount paid as royalties and rent in the production of petroleum was reported as $8,929,891, being one-eighth of the value of the product. In the majority of instances the royalty was a percentage of the oil produced. This percentage ranged from a fraction of 1 per cent to 50 per cent, but the usual amount of petroleum paid to the landowners was one-eighth of the amount marketed or sold to the pipe line companies. In a few cases a fixed amount was paid for each barrel. In northern Pennsylvania and southeastern Ohio a comparatively small amount of superior petroleum was produced, for which the operators paid one-sixth. Part of the petroleum produced in Kansas and Texas, and practically all of that produced in California, paid one-tenth.

The manner in which the amount of royalty to be paid is determined and the method of payment is described by Mr. F. H. Oliphant, in the United States Geological Survey monograph, "The Production of Petroleum," 1902, pages 41 and 42.[1]

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[1] Includes operators distributed as follows: Alabama, 49; Arkansas, 25; California, 1; Indian Territory, 31; Maryland, 17; Michigan, 28; Montana, 4; New Mexico, 7; North Dakota, 6; Oregon, 4; Tennessee, 38; Texas, 9; Utah, 3; Virginia, 17; Washington, 10; Wyoming, 9

In the production of natural gas $2,533,895 was reported as rent and royalties. The usual rent paid for a gas well was from $100 to $300 per year.[2]

The following statement shows the amount of royalties and rent paid in the production of natural gas and petroleum in each state and the percentages the amounts so paid bear to the value of the product for the states and for the United States:

STATE.	NATURAL GAS.		PETROLEUM.	
	Amount paid for royalties and rent of mine and mining plant.	Per cent of value of product.	Amount paid for royalties and rent of mine and mining plant.	Per cent of value of product.
United States	$2,533,895	8.2	$8,929,891	12.5
California			214,261	4.4
Colorado			18,597	3.8
Indiana	539,844	7.6	1,034,070	15.8
Kansas	21,088	2.6	28,255	9.7
Kentucky	8,725	2.4	83,613	31.0
New York	82,489	9.4	194,717	12.7
Ohio	198,671	8.4	3,016,994	14.7
Pennsylvania	1,223,278	8.5	1,916,987	12.6
Texas	2,082	18.6	261,150	6.3
West Virginia	507,868	9.4	2,132,243	12.5
All other states and territories[1]			29,004	10.4

[1] Includes Illinois (no royalties paid), Indian Territory, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming.

In the group of metallic ores the largest amount was paid in royalties in the production of iron ore, the total, $6,503,908, paid in this branch of mining forming 67.8 per cent of the $9,591,964 reported for the entire metallic group.

The following statement shows the amounts paid as royalties and rent in the iron mines in the different states and the percentage that total is of the total for the United States:

STATE.	Amount paid for royalties and rent of mine and mining plant.	Per cent of total.
United States	$6,503,908	100.0
Alabama	37,988	0.6
Colorado	87,094	1.3
Georgia	8,351	0.1
Maryland	2,271	(1)
Michigan	2,254,864	34.7
Minnesota	3,648,750	56.1
Missouri	2,538	(1)
New Jersey	7,915	0.1
New York	12,386	0.2
Ohio	1,503	(1)
Pennsylvania	26,313	0.4
Tennessee	93,672	1.5
Virginia	93,129	1.5
Wisconsin	181,243	2.8
All other states and territories	46,612	0.7

[1] Less than one-tenth of 1 per cent.

The operators in the states of Michigan and Minnesota paid $5,903,614 in royalties and rent, or 90.8 per cent of the total amount paid in the United States. Of the 72 operators reported for these states, 61 paid either rent or royalty. The state of Minnesota has adopted a system of leasing its iron lands for a term of years to prospectors and miners, and a royalty of 25 cents per ton is imposed on all iron ore mined and shipped from state lands. The state has received $332,119.02 in royalties on iron ore actually shipped up to the end of the fiscal year, July 31, 1902, and by annual payments on mining contracts, payment for prospecting leases, and as royalty on a minimum output of 5,000 tons per year, the further sum of $212,515.75 has been turned into the state treasury, making a total of $544,634.77.[1]

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[1] The pipe line company, upon application from the producer, sends an agent, generally known as a "gauger," to measure and inspect the petroleum in his tank and run it into its lines, the tanks throughout the field having been carefully measured and a card issued showing the number of barrels from top to bottom to each inch of liquid. From his blank book the gauger gives the operator a "run ticket," sending a duplicate to the nearest general office as well as reporting the amount by telegraph, keeping a third one himself. The pipe line company deducts the amount due the owner of the property according to the terms of an agreement on file at the office, known as the royalty, and the next day the producer can secure the cash for his petroleum at the market quotation for the day or hour of his sale, at the nearest home office of the company, from a purchaser for the refining companies; or, if the producer wishes, he can obtain a certificate when his production in the tanks of the pipe line company amounts to 1,000 barrels.

These certificates are made payable to bearer, and are therefore transferable. They are subject to a transportation charge in the district of 20 cents per barrel and a charge for storage at the rate of 25 cents per day per 1,000 barrels when the price is less than $1, 30 cents when over $1 and under $1.50, and 40 cents for all over $1.50 per barrel. They are to be returned for exchange to the pipe line company within six months after issue, or be subject to a charge of one-twentieth of 1 per cent daily thereafter until exchanged. To cover losses by fire or lightning certificates are subject to an assessment pro rata on all oil in the custody of the pipe line. None of these charges are included in the prices of petroleum as quoted, and therefore the prices given are the prices at or near the wells. This system, by which the operator can always find a market for his production at a common price known to all, has done much to develop the oil resources of the United States. Other countries have suffered where there were no organized lines of transportation and storage to enable the producer to dispose of his products regularly.

[2] The form of lease for petroleum and gas wells is generally as follows:

Agreement made and entered into the —— day of ——, A. D. 190—, by and between ——, of ——, county of —— and state of ——, part—— of the first part, and —— part—— of the second part.

Witnesseth, That the said part—— of the first part, for and in consideration of the sum of one dollar to —— in hand well and truly paid by the said part—— of the second part, the receipt of which is hereby acknowledged, and of the covenants and agreements hereinafter contained on the part of the said party of the second part, to be paid, kept, and performed, ha—— granted, demised, leased, and let and by these presents do—— grant, demise, lease, and let unto the said part—— of the second part, —— heirs, executors, administrators, or assigns, for the sole and only purposes of mining and operating for oil and gas, and of laying pipe lines, and of building tanks, stations, and structures thereon to take care of the said products, all that certain tract of land, situate in —— township, —— county, and state of ——, on waters of ——, bounded substantially as follows: On the north by lands of ——; on the east by lands of ——; on the south by lands of ——; on the west by lands of ——; containing —— acres, more or less, and being same land conveyed to the first part—— by —— by deed, bearing date ——, 18—, reserving, however, therefrom —— feet around the buildings on which no well shall be drilled by either party except by mutual consent.

It is agreed that this lease shall remain in force for the term of ten years from this date, and as long thereafter as oil or gas or either of them is produced therefrom by the party of the second part, —— heirs, executors, administrators, or assigns.

In consideration of the premises the said part—— of the second part covenants and agrees. First. To deliver to the credit of the first part——, —— heirs or assigns, free of cost, in the pipe line to which it may connect its wells, the equal one-eighth part of all oil produced and saved from the leased premises; and, second, to pay 100 to 300 dollars per year for the gas from each and every gas well drilled on said premises, the product from which is marketed and used off the premises, said payment to be made on each well within sixty days after commencing to use the gas therefrom, as aforesaid, and to be paid yearly thereafter while the gas from said well is so used.

Second part—— covenant—and agree— to locate all wells so as to interfere as little as possible with the cultivated portions of the farm. And further, to commence a well on said premises within —— from the date hereof, or pay at the rate of —— dollars quarterly, in advance, for each additional three months such commencement is delayed from the time above mentioned for the commencement of such well until a well is commenced; and it is agreed that the commencement of such well shall be and operate as a full liquidation of all rental under this provision during the remainder of the term of this lease. Such payments may be made direct to the lessor— or deposited to —— credit in ——.

It is agreed that the second party is to have the privilege of using sufficient water from the premises to run all necessary machinery, and at any time to remove all machinery and fixtures placed on said premises; and, further, upon the payment of —— dollars at any time by the party of the second part, —— heirs, executors, administrators, or assigns to the part—— of the first part, —— heirs, executors, administrators, or assigns, said party of the second part, —— heirs, executors, administrators, or assigns shall have the right to surrender this lease for cancellation, after which all payments and liabilities thereafter to accrue under and by virtue of its terms shall cease and determine, and this lease become absolutely null and void.

In witness whereof the parties to this agreement have hereunto set their hands and seals the day and year first above written.

Zinc mining lands are seldom sold, but are usually worked on royalties. Lands which have never been prospected are leased on a percentage royalty. The lessee prospects the land and lots are then subleased to mine operators at a larger percentage royalty than is paid by the first lessee. The first lessee usually contracts to put in pumping plants and keep the tract drained. The ore is sold in the bins and payment is made to the landowner or first lessee, who deducts his royalty and pays over the balance to the operator. Very frequently the sublessee further leases small plots to miners, usually neighboring farmers, who undertake to work the land on a royalty. The larger land companies buy all ore produced by these miners at a stipulated price, deducting from it the royalty. In such cases the terms resemble contract mining as practiced in other branches of the mining industry. The total amount of royalties reported for zinc mines at the Twelfth Census was $1,525,368. The royalty is computed on the price paid by the purchaser for ore in the bins; if the ore sells at $30 per ton and the royalty is 20 per cent, the landowner deducts $6 per ton for his royalty and draws his check for $24 to the operator.

Mining on royalties is of little importance in the copper mining industry. The total amount of royalties and rents paid in 1902 was $130,215, of which only $33,184 represented royalties. This was about 25 per cent of the gross value of the ore upon which the royalties were paid. Considering that the total production of copper ore was valued at $51,178,036 at the mine, it is apparent that royalties can not be considered a factor in copper mining.

In gold and silver mines the royalty is usually stipulated at a certain percentage of the net value realized for the ore, after deducting treatment charges and freight; the rate increases with the grade of the ore. Thus if the ore is worth $20 per ton, the cost of treatment and freight is $10, and the rate of royalty is 25 per cent; then the landowner is paid $2.50 per ton, which leaves $7.50 for the operator. Sometimes, though seldom, the rate is stipulated upon the gross value say 10 per cent of the assay value of the ore; taking the same figures as in the preceding example, the royalty would amount to $2, which would leave for the operator $18, from which $10 would be deducted for treatment and freight, leaving a net balance of $8 for the operator.

In Colorado, where the mines are often leased in "blocks" to miners who perform the labor personally, the ore is marketed by the owner or shipped in his name, and he deducts his royalty and pays the balance to the lessee. When the ore is sold to a "sampler" (ore buyer), he frequently withholds the royalty for the owner and pays the balance to the lessee.

XV.

COST OF SUPPLIES AND MATERIALS.

The cost of supplies and materials of all kinds used in the mining industries during the year, including freight on the same when paid by the mine operator, amounted to $123,814,967. This includes lumber and timber used for repairs, mine supports, track ties, cars, and other purposes; iron and steel for blacksmithing, rails, frogs, sleepers, etc., for tracks; miscellaneous materials, parts of machinery, and tools used for renewals and repairs; and also explosives, water for boilers and other purposes, fuel, illuminating and lubricating oils, machinery, supplies, etc. Supplies may have been purchased with the intention of taking advantage of low prices, but only the cost of those used during the year was reported. The "material" operated upon in a mine is the mineral in place, and its cost is included in the cost of the land or in the amounts paid for royalty and rent. All the items here enumerated come under the definition of "supplies," and the total cost may be accepted as representing the purchase of supplies, with the exception of the purchase of lime rock by quarry companies engaged in the manufacture of cement. The totals are summarized in Table 54 and placed in comparison with the value of product for each mineral and group of minerals.

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[1] Report of the auditor of the state of Minnesota for the fiscal year ending July 31, 1902.

TABLE 54.—COST OF SUPPLIES AND MATERIALS, AND PERCENTAGE THIS IS OF VALUE OF PRODUCT, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	Cost of supplies and materials.	Value of product.	Percentage that cost of supplies and materials is of value of product.
Total	$123,811,967	$796,826,417	15.5
Metallic	39,639,763	215,131,587	18.4
Copper ore	11,083,175	51,178,036	21.7
Gold and silver	16,699,768	82,482,042	20.2
Iron ore	9,005,608	65,465,421	13.8
Lead and zinc ore	2,511,667	14,630,177	17.2
Manganese ore	17,228	177,911	9.7
Quicksilver	322,267	1,550,060	20.8
Fuels	61,928,469	469,297,671	13.2
Coal, anthracite	12,740,780	76,173,586	16.7
Coal, bituminous	24,798,922	290,858,483	8.5
Natural gas	6,607,255	30,867,863	21.4
Petroleum	17,781,512	71,397,789	24.9
Structural materials	20,072,399	96,370,569	20.8
Cement	9,098,226	24,268,538	37.5
Clay	272,823	2,061,072	13.2
Limestones and dolomites	5,401,912	30,441,801	17.8
Marble	825,822	5,044,182	16.4
Sandstones and quartzites	1,298,190	10,601,171	12.2
Siliceous crystalline rocks	2,493,065	18,257,944	13.7
Slate	680,361	5,696,051	11.9
Abrasive materials	80,309	1,177,711	6.8
Buhrstones and millstones	1,899	59,808	3.0
Corundum and emery	26,114	104,605	25.0
Crystalline quartz	956	43,085	2.2
Garnet	10,128	132,820	7.6
Grindstones and pulpstones	31,349	667,431	4.7
Infusorial earth, tripoli, and pumice	2,297	55,993	4.1
Oilstones, whetstones, and scythe stones	7,662	113,968	6.7
Chemical materials	$1,603,548	$10,618,669	15.1
Borax	213,538	2,384,614	9.0
Fluorspar	31,374	275,682	11.4
Gypsum	341,760	2,089,341	16.4
Phosphate rock	799,414	4,922,943	16.2
Sulphur and pyrite	217,262	947,089	22.9
Pigments	65,845	564,039	11.7
Barytes	7,772	203,154	3.8
Mineral pigments, crude	58,073	360,885	16.1
Miscellaneous	424,894	3,344,181	12.7
Asbestos	8,233	46,200	17.8
Asphaltum and bituminous rock	21,928	236,728	9.3
Bauxite	40,019	128,206	31.2
Feldspar	50,278	250,424	20.1
Flint	18,642	144,209	12.9
Fuller's earth	28,946	98,144	29.5
Graphite	51,840	227,608	22.8
Lithium ore	1,265	25,750	4.9
Marl	2,758	12,741	21.6
Mica	11,981	118,849	10.1
Monazite	256	64,160	0.4
Precious stones	17,781	328,450	5.4
Silica sand	8,390	421,289	2.0
Talc and soapstone	125,912	1,138,167	11.1
Tungsten	210	5,975	3.5
Uranium and vanadium	3,660	58,125	6.3
All other minerals	3,432	49,256	7.0

The various conditions under which mining operations are carried on destroy the possibility of a fixed ratio between the cost of supplies and the value of product for any mineral or group of minerals; therefore the percentages given in the above table should not be accepted as indicating such a ratio. They show only the relative importance of this item of expense for all mines, irrespective of the conditions under which they were operated. The total amount paid for supplies and materials for the entire mining industry was 15.5 per cent of the total value of product. The percentages that cost of supplies and materials formed of the value of the product ranged from 0.4 per cent for monazite to 37.5 per cent for cement. The high proportional cost in the latter was due in part to the fact that some crude cement rock was purchased from quarries that were not equipped for manufacturing cement, and large amounts were paid for cooperage stock, barrels, and other packages in which the product was packed for shipment.

XVI.

POWER AND MACHINERY.

The use of power is becoming more general in all branches of productive industry. In the mining industries power is employed for a variety of purposes, the chief of which are the operation of hoisting, draining, ventilating, conveying, drilling, and cutting machinery, derricks, steam shovels, and locomotives and hauling engines. It is also employed extensively in the operation of machinery used in crushing, screening, cleaning, or otherwise treating the crude material. Motive power is now generally used in all mining operations of any magnitude.

Table 55 shows the number of operators reporting the use of power and the value of their products in comparison with the total number and value of products for all operators for each classification and group of minerals.

TABLE 55.—NUMBER OF OPERATORS REPORTING USE OF POWER AND THE VALUE OF THEIR PRODUCTS COMPARED WITH TOTALS FOR ALL OPERATORS, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	NUMBER OF OPERATORS.			VALUE OF PRODUCT.		
	Total.	Reporting use of power.	Per cent which number reporting use of power forms of total number.	Total.	For operators reporting use of power.	Per cent which value of product for operators reporting use of power forms of total value.
All minerals	46,858	35,943	76.7	$796,826,417	$732,321,376	91.9
Metallic	4,081	2,058	50.4	215,453,587	204,829,082	95.1
Copper ore	144	102	70.8	51,178,036	50,837,067	99.3
Gold and silver	2,992	1,297	43.3	82,462,092	77,331,374	93.8
Iron ore	332	237	71.4	65,465,821	63,378,314	96.8
Lead and zinc ore	557	389	69.8	14,600,177	11,736,157	80.4
Manganese ore	19	5	26.3	177,911	37,806	21.2
Quicksilver	37	28	75.7	1,550,090	1,508,364	97.3
Fuels	36,017	[1]31,562	87.6	469,297,671	431,437,498	91.9
Coal, anthracite	119	119	100.0	76,173,586	76,173,586	100.0
Coal, bituminous	4,409	1,819	41.3	290,858,483	263,062,394	90.4
Natural gas	1,967	175	8.9	30,867,863	21,076,371	68.3
Petroleum	29,522	[1]29,449	99.8	71,397,739	71,125,147	99.6
Structural materials	5,746	2,041	35.5	96,370,559	83,103,040	86.2
Cement	93	89	95.7	24,268,538	24,137,396	99.5
Clay	203	68	33.5	2,061,072	1,337,220	64.9
Limestones and dolomites	3,137	862	27.5	30,441,801	23,622,513	77.7
Marble	75	55	73.3	5,044,182	4,906,308	97.3
Sandstones and quartzites	1,211	294	24.3	10,601,171	8,077,970	76.2
Siliceous crystalline rocks	853	519	60.8	18,257,944	15,416,935	84.4
Slate	174	154	88.5	5,696,051	5,564,698	97.7
Abrasive materials	75	29	38.7	1,177,711	565,697	48.0
Buhrstones and millstones	29	1	3.4	59,808	5,400	9.0
Corundum and emery	5	3	60.0	104,605	94,785	90.6
Crystalline quartz	5	1	20.0	43,085	12,000	27.9
Garnet	7	5	71.4	132,820	91,760	69.1
Grindstones and pulpstones	9	5	55.6	667,431	252,069	37.8
Infusorial earth, tripoli, and pumice	10	6	60.0	55,994	49,783	88.9
Oilstones, whetstones, and scythestones	10	8	80.0	113,968	59,900	52.6
Chemical materials	174	128	73.6	10,618,669	9,685,554	91.2
Borax	6	6	100.0	2,383,614	2,383,614	100.0
Fluorspar	18	12	66.7	275,682	261,210	94.8
Gypsum	45	41	91.1	2,089,311	2,044,188	97.8
Phosphate rock	87	56	64.4	4,922,943	4,293,434	87.2
Sulphur and pyrite	18	13	72.2	947,089	703,108	74.2
Pigments	77	23	29.9	564,039	281,120	49.8
Barytes	42	2	4.8	203,154	23,500	11.6
Mineral pigments, crude	35	21	60.0	360,885	257,620	71.4
Miscellaneous	688	102	14.8	3,344,181	2,423,385	72.5
Asbestos	4	2	50.0	46,200	36,000	77.9
Asphaltum and bituminous rock	24	8	33.3	236,728	51,809	21.9
Bauxite	7	6	85.7	128,206	128,131	99.9
Feldspar	26	12	46.2	250,424	138,045	55.1
Flint	17	8	47.1	144,209	112,251	77.8
Fuller's earth	4	4	100.0	98,144	98,144	100.0
Graphite	19	11	57.9	227,508	204,218	89.8
Lithium ore	3	....	....	25,750	....	....
Marl	11	1	9.1	12,740	4,267	33.5
Mica	38	7	18.4	118,849	31,865	26.8
Monazite	22	1	4.5	64,160	5	(2)
Precious stones	461	3	0.7	328,450	110,500	33.6
Silica sand	20	19	95.0	421,289	354,242	84.1
Talc and soapstone	20	16	80.0	1,138,787	1,127,625	99.1
Tungsten	4	2	50.0	5,975	4,731	79.2
Uranium and vanadium	2	....	....	48,125	....	....
All other minerals[3]	6	2	33.3	49,256	20,889	42.4

[1] Includes 28,925 operators reported by the Standard Oil Company, for which statistics of power were reported collectively.

[2] Less than one-tenth of 1 per cent.

[3] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Of the 46,858 operators reported for all classes of minerals, 35,943, or 76.7 per cent, reported the use of power. The value of the products reported by operators using power amounted to $732,324,376, or 91.9 per cent, of the total value of products for all operators. In other words, all but 8.1 per cent of the mineral products of the country were obtained by operators who reported the use of power to some extent.

The entire production of anthracite coal, borax, fuller's earth, magnesite, and rutile was obtained by operators using power. For ten of the different classifications of minerals enumerated in the above table the use of power was reported by operators producing more than 95, but less than 100 per cent of the value of product. Of the seven groups of minerals the metallic group shows the largest proportion, 95.1 per cent, for the products obtained by operators using power. The next largest proportion, 91.9 per cent, is shown for the group of fuels, while for the remaining groups the percentages of the products obtained by the use of power are as follows: 91.2 per cent for chemical materials, 86.2 per cent for structural materials, 72.5 per cent for miscellaneous materials, 49.8 per cent for pigments, and 48 per cent for abrasive materials. The table shows very conclusively that practically all of the large producers employed mechanical power in some form.

In compiling these statistics, steam, gas or gasoline, and water were considered as primary power, and rented power of all classes was included under the same head. Gas engines embrace all forms of internal combustion engines in which the propelling force is the explosion of gaseous or vaporous fluid in direct contact with a piston within a closed cylinder. The inquiry concerning mechanical power called for a full report of all power employed, either owned or rented, including the number and horsepower of all engines, motors, water wheels, etc., used for ventilating, pumping, hoisting, derricks, surface machinery, and all other purposes. The power reported in answer to this inquiry amounted to 2,867,562 horsepower for all branches of mining. Of this total, 2,432,963 horsepower, or 84.9 per cent, was steampower; 60,897 horsepower, or 2.1 per cent, was waterpower; and 373,702 horsepower, or 13 per cent, was obtained from other forms of mechanical power, including electricity, gas engines, air compressors, etc. The use of steampower largely predominated in mining operations, other forms of primary power in comparison having only a limited application. While inquiries concerning power were included in the schedules used at previous censuses, they do not appear to have been answered uniformly, and the comparisons can not be accepted as an accurate indication of the increase in the quantity of power employed. The following table, however, presents the total horsepower reported at the censuses from 1870 to 1902:

TABLE 56.—*Horsepower: 1870 to 1902.*

MINERAL.	TOTAL HORSEPOWER.			
	1902	1889[1]	1880	1870
Asbestos	105	(2)	(2)	(2)
Asphaltum and bituminous rock	720	(2)	(2)	50
Barytes	110	(2)	(2)	(2)
Bauxite	624	(2)	(2)	(2)
Borax	338	(2)	(2)	(2)
Buhrstones and millstones	85	(2)	(2)	(2)
Cement	114,092	(2)	3,115	2,090
Clay	1,478	(2)	351	1,201
Coal, anthracite	131,220	160,983	165,807	49,280
Coal, bituminous	521,165	54,795	26,191	13,361
Copper ore	198,507	34,390	13,541	6,388
Corundum and emery	110	(2)	16	(2)
Crystalline quartz	20	(2)	(2)	(2)
Feldspar	1,204	(2)	28	(2)
Flint	740	(2)	(2)	(2)
Fluorspar	669	(2)	(2)	(2)
Fuller's earth	400	(2)	(2)	(2)
Garnet	450	(2)	(2)	(2)
Gold and silver	195,865	78,343	[3]24,929	5,606
Graphite	769	505	330	(2)
Grindstones and pulpstones	1,247	(2)	(2)	(2)
Gypsum	7,319	2,015	(2)	(2)
Infusorial earth, tripoli, and pumice	110	(2)	(2)	(2)
Iron ore	119,558	57,976	24,838	8,927
Lead and zinc ore	11,901	[4]1,133	[5]6,739	984
Limestones and dolomites	64,500	22,362	195	[6]1,737
Magnesite	15	(2)	(2)	(2)
Manganese ore	354	(2)	87	(2)
Marble	14,296	11,392	(7)	636
Marl	50	(2)	(2)	(2)
Mica	185	(2)	(2)	(2)
Mineral pigments, crude	1,840	(2)	158	(2)
Monazite	30	(2)	(2)	(2)
Natural gas	104,107	(2)	(2)	(2)
Nickel and cobalt	(2)	140	155	132
Oilstones, whetstones, and scythestones	193	(2)	10	(2)
Petroleum	910,077	(2)	(2)	23,482
Phosphate rock	14,229	50	(2)	(2)
Precious stones	150	(2)	(2)	(2)
Quicksilver	1,808	2,441	(2)	147
Rutile	30	(2)	(2)	(2)
Sandstones and quartzites	25,652	15,510	(2)	(2)
Silica sand	2,100	(2)	286	(2)
Siliceous crystalline rocks	16,986	15,199	(2)	(2)
Slate	25,454	12,037	(2)	671
Sulphur and pyrite	6,305	(2)	(2)	(2)
Talc and soapstone	3,945	(2)	(2)	(2)
Tungsten	280	(2)	(2)	(2)

[1] Horsepower of boilers reported.
[2] Not reported.
[3] Exclusive of waterpower used at arrastra mills and all power at stamp and amalgamating mills.
[4] Reported for eastern and southern zinc mines only.
[5] Reported for mines east of the one hundredth meridian.
[6] Includes all stone except marble and slate.
[7] Included with limestones and dolomites.

Since statistics for power were not reported in a uniform manner at these censuses, the totals for the United States are not shown in Table 56. The figures can be accepted only as an indication of the more general use of power in mining operations and not as a basis for computing the actual increase in the horsepower employed in the industry. The inquiry for 1902 was confined to the operation of mines, quarries, or wells and such manufacturing processes as were carried on in immediate connection therewith. A number of minerals for which power was reported at the census of 1902 were not produced in commercial quantities at one or more of the three preceding censuses, or if they were so produced, power was not reported as employed in the mining operations.

The detailed statistics for the different varieties of power reported for each mineral, each group of minerals, and for all minerals in each state are shown in Tables 1 and 2, pages 347 to 377. The following table shows the number of operators in each class of minerals and group of minerals reporting the use of the different varieties of power, and the total amount of horsepower employed:

TABLE 57.—NUMBER OF OPERATORS REPORTING THE USE OF THE DIFFERENT KINDS OF POWER, AND TOTAL HORSEPOWER: 1902.

MINERALS, BY GROUPS.	OPERATORS.		Total horse-power.	STEAM ENGINES.		GAS OR GASOLINE ENGINES.		WATER WHEELS.		ALL OTHER POWER.	
	Total number.	Number reporting power.		Number of operators reporting.	Horse-power.	Number of operators reporting.	Horse-power.	Number of operators reporting.	Horse-power.	Number of operators reporting.	Horse-power.
All minerals	46,868	¹35,943	2,867,562	35,060	¹2,432,963	29,530	259,665	471	60,897	753	114,017
Metallic	4,061	2,058	557,983	1,640	455,202	205	5,913	397	45,614	331	51,204
Copper ore	144	102	198,507	92	189,425	19	1,184	6	326	29	7,571
Gold and silver	2,922	1,297	196,806	922	122,351	142	1,060	381	43,926	207	25,475
Iron ore	282	237	119,548	233	102,878	9	86	5	1,010	64	15,784
Lead and zinc ore	657	389	41,901	365	38,616	24	431	2	320	30	2,534
Manganese ore	12	5	354	5	354						
Quicksilver	57	28	1,808	23	1,571	9	152	3	22	1	60
Fuels	36,017	¹31,562	1,969,569	31,237	1,663,227	29,223	248,892	6	1,584	329	53,066
Coal, anthracite	119	119	434,220	119	415,827	5	185			20	18,208
Coal, bituminous	4,409	1,819	521,165	1,748	489,628	117	1,119	6	1,584	118	29,034
Natural gas	1,967	175	104,107	122	91,595	79	7,088			9	2,429
Petroleum	29,522	¹29,449	910,077	29,248	666,177	29,024	240,505			182	3,395
Structural materials	5,746	2,041	292,448	1,932	273,517	85	4,286	36	8,610	80	9,035
Cement	96	89	114,092	84	103,811	1	2,890	6	1,854	9	5,537
Clay	200	68	4,478	65	3,842	2	18	1	25	8	593
Limestones and dolomites	3,137	862	64,500	823	61,547	55	1,031	10	592	21	1,120
Marble	75	55	11,286	54	10,748			6	3,413	1	125
Sandstones and quartzites	1,211	291	25,652	275	24,663	7	72	3	885	8	64
Siliceous crystalline rocks	853	519	46,986	479	44,189	20	275	7	1,396	21	1,026
Slate	174	154	25,454	152	24,649			3	425	6	380
Abrasive materials	75	29	2,205	26	2,010	2	88			3	107
Buhrstones and millstones	29	1	85							1	85
Corundum and emery	5	3	110	2	30	1	80				
Crystalline quartz	5	1	30	1	30						
Garnet	7	5	430	5	420					1	10
Grindstones and pulpstones	9	5	1,247	5	1,235					1	12
Infusorial earth, tripoli, and pumice	10	6	110	6	110						
Oilstones, whetstones, and scythestones	10	8	193	7	185	1	8				
Chemical materials	174	128	28,860	116	27,008	9	302	12	1,094	5	455
Borax	6	6	338	4	204	3	124	1	10		
Fluorspar	18	12	669	11	530	4	139				
Gypsum	45	41	7,319	34	6,385	1	20	10	914		
Phosphate rock	87	56	14,229	56	13,974			1	170	2	85
Sulphur and pyrite	18	13	6,305	11	5,915	1	20			3	370
Pigments	77	23	1,950	21	1,330	1	10	1	550	2	60
Barytes	42	2	110	2	110						
Mineral pigments, crude	35	21	1,840	19	1,220	1	10	1	550	2	60
Miscellaneous	688	102	11,307	88	7,398	7	174	12	3,645	3	90
Asbestos	4	2	105	2	105						
Asphaltum and bituminous rock	21	8	720	7	660	1	60				
Bauxite	7	6	624	6	575	2	49				
Feldspar	25	12	1,204	11	854			3	350		
Flint	17	8	740	3	155			6	585		
Fuller's earth	4	4	460	4	430	2	30				
Graphite	19	11	769	11	749			1	10	1	10
Magnesite	1	1	15	1	15						
Marl	21	1	50	1	50						
Mica	58	7	185	6	160	1	25				
Monazite	22	1	30	1	30						
Precious stones	460	3	150	3	150						
Rutile	1	1	30	1	30						
Silica sand	20	19	2,000	21	1,980					1	20
Talc and soapstone	24	16	3,945	9	1,235	1	10	2	2,700		
Tungsten	4	2	280	1	220					1	60
Uranium and vanadium	2										
All other minerals²	7										

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¹ Includes 28,925 operators reported by the Standard Oil Company for which statistics of power were reported collectively. A large number of operators, therefore, are duplicated in steampower and gas or gasoline power.

² Includes chrome ore, lithium ore, molybdenum, and nickel and cobalt.

All the operators reported for five of the minerals enumerated in the above table used mechanical power. The number of operators reported for the remaining minerals for which power was used includes all the operators of small mines and quarries, a number of whom work at irregular intervals, and the small lessees; therefore the comparison of the number of operators reporting the use of power, with the total number reported for each mineral, does not convey a correct impression of the importance of motive power in the mining industries of the country. The following statement shows the proportion of each variety of power employed in the production of the different groups of minerals:

Per cent of each kind of power employed in the different groups of minerals: 1902.

GROUP.	OPERATORS.		Total horsepower.	POWER.							
				Steam engines.		Gas or gasoline engines.		Water wheels.		All other power.	
	Total number.	Number reporting power.		Number of operators.	Horsepower.	Number of operators.	Horsepower.	Number of operators.	Horsepower.	Number of operators.	Horsepower.
All minerals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Metallic	8.7	5.7	19.4	4.7	18.7	0.7	2.3	84.3	74.9	43.9	44.9
Fuels	76.9	87.8	68.7	89.1	68.5	99.0	95.8	1.3	2.3	43.7	46.6
Structural materials	12.2	5.7	10.3	5.5	11.2	0.3	1.7	7.6	14.1	10.6	7.9
Abrasive materials	0.1	0.1	0.1	0.1	0.1	(1)	(1)	....	....	0.4	0.1
Chemical materials	0.4	0.3	1.0	0.3	1.1	(1)	0.1	2.6	1.8	0.7	0.4
Pigments	0.2	0.1	0.1	0.1	0.1	(1)	(1)	0.2	0.9	0.3	(1)
Miscellaneous	1.5	0.3	0.4	0.2	0.3	(1)	0.1	4.0	6.0	0.4	0.1

[1] Less than one-tenth of 1 per cent.

Of the total power for all minerals, including natural gas and petroleum, 1,969,569 horsepower, or 68.7 per cent, was reported by the operators engaged in the production of fuels. The universal use of power in anthracite coal mining, its very general application in the production of bituminous coal, and its use in the necessary pumping machinery at petroleum wells account for the large amount of power reported for the operators included in this group.

The metallic group, with 557,933 horsepower, or 19.4 per cent of the total, is the second in importance in the quantity of power used. While the operators in this group formed a comparatively small proportion, (5.7 per cent) of the total number of operators reporting the use of power, they produced a very large proportion of the total product. The fact that a large number of small operators reported for gold and silver and bituminous coal used no motive power is the principal reason for the small proportion using power.

While the use of power was an important factor in the production of practically all of the minerals, the horsepower reported for structural materials, abrasive materials, chemical materials, pigments, and miscellaneous minerals formed only 11.9 per cent of the total.

The following statement shows the proportion of steam, gas, water, and other power employed in the production of each group of minerals:

Per cent of operators reporting power, and per cent of those reporting steam, gas, water, or other power, by groups of minerals: 1902.

GROUP.	Per cent of operators reporting power.	POWER.			
		Steam, per cent of total.	Gas or gasoline, per cent of total.	Water, per cent of total.	All other, per cent of total.
All minerals	76.7	84.8	9.1	2.1	4.0
Metallic	50.6	81.6	1.0	8.2	9.2
Fuels	87.6	84.6	12.6	0.1	2.7
Structural materials	35.5	92.6	1.4	2.9	3.1
Abrasive materials	58.7	92.2	3.5	....	4.3
Chemical materials	73.6	90.6	1.0	6.8	1.6
Pigments	29.9	67.2	2.0	28.2	2.6
Miscellaneous	14.8	65.4	1.6	32.2	0.8

There were 35,060 operators, including those for natural gas and petroleum, that reported the use of steampower. This class of power predominated in each of the general groups of minerals and formed 84.8 per cent of the power reported for all mining operations. The use of gas or gasoline engines was reported by 29,530 operators, the horsepower amounting to 259,695, or 9.1 per cent of the total. Engines of this variety predominated in the fuel industries as a result of the free use of natural gas and petroleum for motive power at the wells. The reports showed that 980 water wheels, with 60,897 horsepower, were used by 471 operators, and of this total 43,936 horsepower, or 72.1 per cent, was employed in the production of gold and silver.

The 84,546 horsepower reported for other kinds of power is composed very largely of the horsepower of air compressors.

A number of the mine operators reported that power was supplied by them to other mines or to operators engaged in other industries, there being 2,852 horsepower rented in this manner. A number also reported that they rented power from other operators or power companies, the rented power amounting to 29,461 horsepower, 23,556 of which was electric. The electric power generated by the mine operators amounted to 130,494 horsepower, which, with the electric power rented, makes a total of 154,050 electric horsepower used in the mining industry.

Under the present methods of operation mechanical power for hoisting, ventilating, and pumping is indispensable in mining operations of magnitude. Special inquiries were included in the schedules for gold, silver, and copper mines, concerning the character of power used in the operation of hoisting and pumping engines, and the following statement shows the number of engines employed for this purpose and operated by each class of power.

Number of hoisting and pumping engines employed in gold and silver and copper mining: 1902.

POWER	GOLD AND SILVER.		COPPER	
	Hoisting engines.	Pumping engines.	Hoisting engines.	Pumping engines.
Total	1,249	840	228	160
Steam	968	663	158	153
Gas or gasoline	84	21	16	2
Compressed air	91	84	51	2
Water	50	30	....	2
Electric	56	42	3	1

In addition to the foregoing power the gold and silver and copper mines reported 3,399 power drills. Of these 302 were driven by steam, 3,060 by compressed air, 4 by water, and 33 by electric power. The gold and silver mines used also 32 steam shovels or derricks, and 44 dredges. Forty-nine locomotives also were reported for this industry.

While a perfect system of ventilation is of prime importance in all deep mines, the schedule for coal mines was the only one that contained inquiries on this subject. Of the 334 mines producing anthracite coal, reports for 271 showed the use of fan ventilators and 1 the use of exhaust steam. The remaining 62 reports either contained no answer to the inquiry or the statement was made that no mechanical arrangements were used. Of the reports for the 5,652 bituminous coal mines, 4,844 contained answers to these inquiries, showing that at 2,215, fan ventilators were used; at 1,355, furnaces; at 91, fire baskets; at 70, exhaust steam; while for 1,112 it was reported that ventilation was accomplished without the use of mechanical arrangements.

Mechanical systems of haulage were reported as in use in 201 anthracite mines. In 52 the tail rope was used; in 13, the endless rope; in 27, electric locomotives; and in 28, compressed air; while for 81 miscellaneous systems were reported. In the bituminous coal industry 502 mines used the tail rope; 105, the endless rope; 340, electric locomotives; 19, compressed air; and 65, other systems. In addition to other machinery, automatic slate pickers and coal cleaners were reported as in use at 258 anthracite coal mines.

A brief description is given in the following list of the most important mining machinery operated by motive power:

POWER DRIVEN MINING AND ORE DRESSING MACHINERY.

Air compressor: A machine for compressing air for use as a motive power in mines and quarries and for ventilation in shafts or mines. It may be direct steam driven, or driven from line shaft, electric motor, water wheel, or gas engine, by belt, rope, gearing, or silent chain.

Air drill: See Drill.

Amalgamating pan: A machine for grinding and amalgamating ore. It consists of a flat-bottomed iron pan, about 5 feet in diameter and from 2½ to 3½ feet deep, with an iron cone in the center, and sides nearly or quite vertical. In it a horizontal, annular disk, called a muller, is revolved.

Arrastra or drag-stone mill: A form of apparatus for comminuting gold and silver ores. The name is derived from the Spanish word meaning "to drag," and is indicative of the principle of the apparatus. It consists of a circular pavement from 6 to 20 feet in diameter, with a retaining wall from 2 to 4 feet high around it, made as nearly as possible impervious to water or quicksilver. In the center is a vertical rotating post, to whose radial arms are attached blocks of stone or mullers, which are dragged over the ore in the inclosure, thus crushing it.

Ball grinder: A pulverizer for minerals. It depends upon the attrition of spheres rolling inside a rotating cylinder, the periphery of which is provided with a cast steel ring, perforated with small holes. The heads of the cylinder are of heavy cast iron, lined with steel. It contains several steel balls from 2 to 5 inches in diameter. The steel ring is the crushing plate upon which the balls break up the material to a size varying from a powder to the size of the holes in the ring. In some cases a single large ball is used, moving in a grooved path.

Boring machine: See Drill: Hydraulic boring machine, etc.

Breaker: A machine for reducing ore as it comes from the mine to an approximately uniform size convenient for further working. In jaw crushers the ore is broken between a stationary and a movable jaw. Gyratory crushers, often called "coffee mill" crushers, are in part an application on a large scale of the principle of the ordinary household coffee mill. See also Coal breaker; Roll crusher; Ball grinder; Stamp mill, etc.

Buddle: One of that class of concentrating machines depending upon the principle of the settling of minerals in the order of their specific gravities. In round buddles the tables are convex-conical or concave-conical. In the stationary buddle the pulp is fed from slowly revolving feed pipes running from a main pipe in the center, and discharging at the circumference of the table, if an inward-flow buddle; or from a slowly revolving central feed, if an outward-flow buddle. In the revolving buddle the table revolves, while the feed is stationary. Distributing brushes spread the deposits evenly over the surface of the table.

Bumping table: A suspended table, capable of limited movement, which is subjected to a series of blows or shocks in the plane of its motion.

Chain cutter machine: Machine used to shear or undercut coal. It consists of a low metal bed frame, upon which is mounted a motor that rotates a chain, to which suitable cutting teeth are attached. It can be used only under certain conditions, viz: When the coal is comparatively free from balls of iron pyrites, or when the roof is good and props are not used close to the face of the coal. It can not be used to undercut coal having a squeeze upon it. Machines of the ordinary type perform their work by making a forward cut under the coal, then being withdrawn and moved over to reach fresh coal. This process is repeated across the face of the room. The Sullivan machine is fed under the coal but once, and then makes a continuous cut across the face, being withdrawn only at the farther side of the room.

Channeling machine: A machine for making channels in stone; that is, cutting the stone into blocks without the use of explosives. Its several forms are the track channeler, being a machine mounted on a truck running on a track, carrying a boiler furnishing steam to the machine; or the boiler may be omitted, the machine being driven by compressed air from mains; or the truck may carry a reheater for reheating the compressed air before it reaches the machine; the undercutting track channeler, similar to the above, but without boiler and cutting horizontally; the bar channeler, in which the cutting machine travels on a stationary bar. Any of these machines may be driven by either steam or compressed air.

Chilian mill: An apparatus in which the ore is crushed under vertical rollers running in a circular inclosure with a stone or iron base or die. The rollers rotate on a horizontal axis and also around a common vertical center.

Coal breaker: A machine for crushing lump coal as taken from the mine. It is also adapted for cleansing and sorting.

Coal conveyer: See Conveyer.

Coal cutter: See Pick machine.

Coal washer: A machine in which coal that has been broken and assorted is finally washed to deprive it of the dust and dirt adhering.

Compressor: See Air compressor.

Concentrator: General name applied to all machines for concentrating the mineral values of an ore to a smaller bulk in order to get rid of as much superfluous material as practicable.

Conveyer: An endless belt or chain device for transporting ore or coal.

Crossover dump: A contrivance for dumping cars on the mine tipple, which automatically dumps the car, restores it to its original position, and returns it to the mine.

Crusher: See Breaker.

Diamond drill. See Drill.

Dredge: A machine used in placer mining where streams can not be diverted from their course so as to expose the bed, or where bench placers do not have sufficient water for hydraulicking. A floating dredge is used for mining gravel under water; a traction dredge for "dry" or land mining. Dredges may be divided into two classes—those using a line of buckets on an endless chain, and those of the dipper type, which use a single bucket like a steam shovel.

Drill: A machine operated by steam, electricity, or compressed air, for boring. They are of two classes, percussive and rotary. A percussion drill consists of a cylinder in which works a piston carrying a long piston rod, and which is supported in such a manner that the drill, clamped to the end of the piston rod, alternately strikes and is withdrawn from the rock as the piston reciprocates back and forth in the cylinder. Means are provided by which the piston rod and drill turn slightly on their axis after each stroke. Rotary drills differ from percussive drills in the fact that the drill makes its way into the rock by a boring action produced by the axial rotation of the drill rod. Diamond drills are of the latter class, the drilling tool being a hollow cylinder armed with diamonds on its cutting end. See also Hydraulic boring machine; Gadder, etc.

Drill steel sharpener A device driven by compressed air for sharpening steels for drills, channelers, etc.

Electric drill: See Drill.

Electric locomotive: See Mine locomotive.

Electric pump: A mine pump operated by electricity.

Elevator: A machine, consisting of series of buckets attached to an endless chain or belt, for lifting materials from one height to another.

Feeder: A machine for automatically delivering ore in proper quantities and at a definite rate to stamp batteries, roll grinders, etc.

Gadder: A machine by which holes are inserted into the side of the bench, for the insertion of plugs and feathers, by means of which the blocks are separated in the quarry. It may be driven by steam or compressed air.

Gravity stamp: See Stamp mill.

Grinder: See Breaker; Ball grinder; Stamp mill, etc.

Haulage engine: A stationary engine for hauling mine cars by means of tail rope or endless rope systems.

Header: A machine used principally for entry dividing, especially where it is not desired to make lump coal, and where the work must be pushed rapidly. The machine cuts a cylinder of coal about 4 feet in diameter and about 5 feet in length.

Hoisting engine: An engine for hoisting men or materials from a mine.

Hydraulic boring machine: A machine in which the rock drilling machine is actuated by the force of water under pressure, conducted by pipes to the breast of the tunnel.

Hydraulic coal miner: An apparatus for breaking down coal by means of an expanding plug worked by hydraulic pressure.

Jaw crusher: See Breaker.

Jig: A machine in which concentration is effected by giving a column of water a pulsating motion, or by giving the grating and screen, upon which a bed of ore lies, a short reciprocating motion, the resistance of the water lifting up the bed on the down stroke of the piston or grating and the particles assorting themselves as they settle back. The principle of the jig is the tendency of the particles of a bed of ore in water, when approximately of the same size, to arrange themselves in layers according to their specific gravity when the bed is kept sufficiently open to allow the particles to move freely among themselves.

Keeve: A round tub in which the separation is effected by means of stirring paddles, attached to and operated by a vertical shaft passing up through the center of the tub, and by hammers automatically striking the outside of the tub.

Long-wall mining machine: A machine especially designed for undercutting a long-wall face. It consists of an engine or motor mounted on a bed frame and a large cutter wheel in the periphery of which are placed the cutters or bits in a manner similar to that employed in setting the cutters in a chain cutter machine. The bed frame is mounted on wheels which run either on a single rail or an ordinary track laid parallel to the face of the coal. In machines of the Sullivan type the cutter consists of a bar of oblong shape, on which runs a chain carrying cutters or bits. This bar is similar to that used in the chain cutter machine. The machine travels along the bottom of the mine on a flat steel shoe, rails being unnecessary for its operation. The machine takes its motion along the face from a feed chain.

Mechanical conveyer: See Conveyer.

Mill: See Stamp mill.

Mine locomotive: Small, compactly built locomotive for use in mines. In the steam mine locomotive the water tank is set over the boiler, and the smokestack and top of the cab are on a level low enough to permit entrance into the mine passages. The compressed air locomotive requires a stationary air compressing plant and usually pipe lines to convey the compressed air to convenient points in the mine for charging purposes. The electric locomotive also requires a power generating station and is operated in a manner similar to an electric trolley car, using a conducting wire along the haulage road. A variation of the electric mine locomotives is the rack rail locomotive. This locomotive is propelled by sprocket wheels that mesh with the stationary rack laid parallel with the rail, the object being to obtain a great drawbar pull from a light locomotive of small outline dimensions. It is also able to climb steep grades. The electric current is carried to the locomotive in the rack and returned in the track rail.

Ore breaker: See Breaker.

Ore conveyer: See Conveyer.

Ore crusher: See Breaker.

Pick machine: A reciprocating percussive machine used to shear or undercut coal, etc. In undercutting the machine is mounted on small wheels; in shearing, these are removed and large wheels substituted.

Pneumatic drill: See Drill.

Pneumatic pump: A pump operated by compressed air.

Pneumatic stamp: See Stamp mill.

Pulsometer: A water raising device on the principle of the Savery engine. It will raise water by suction to a height of about 26 feet and, if necessary, force it to a height of about 100 feet. Its utility in mining operations lies in the fact that it will pump anything that can get past the valves, including mud, gravel, etc.

Pulverizer: See Roll crusher; Ball grinder; Stamp mill, etc.

Pump: See Steam pump; Sinking pump; Pulsometer, etc.

Riddle. A shaking screen with plane surface. They may be divided into four groups—shaking screens having an endwise or sidewise motion in the plane of the screen, or nearly so, with or without a bump; pulsating screens having an up-and-down motion perpendicular, or nearly so, to the plane of the screen; gyrating screens with a circular or elliptical motion in the plane of the screen; gyrating screens with motion in a vertical plane parallel to their lengths.

Rock breaker: See Breaker.

Roll crusher: A machine for crushing ore to definite sizes. In roll crushers the ore is broken between two cylinders revolving in opposite directions on parallel horizontal axes.

Roller mill: A form of crushing machine in which the crushing is done by rollers moving around in a horizontal pan. They are of two general types, radial and centrifugal. In the radial roller mill the axis of the roller is a continuation of the radial arm. The rollers of the centrifugal mill revolve on independent axes and are free to swing outward in a radial direction, the rapid revolution of the central spindle causing the rollers to press against a hardened ring die in the side of the pan. See, also, Chilian mill.

Screen, revolving. A cylindrical rotating device consisting of perforated plate or woven wire for assorting material into different sizes. See, also, Trommel.

Screen, shaker: A device made of perforated plate, bars, or woven wire, to which is imparted a reciprocating motion for the purpose of separating material into different sizes. See, also, Riddle.

Shaft excavator: A system of apparatus for sinking shafts in coal mines.

Shearer: A machine for making vertical cuts in a stratum of coal. See, also, Pick machine.

Sinking pump: Portable pump used to drain water from the shaft bottom. It is especially adapted to the recovery of flooded mines. These pumps are suspended by a chain attached to eyebolts in the pump, and are provided with clamps for attaching them to the timbers in the shaft when it is desired to fix them in position temporarily. As the shaft gets deeper, the chain may be lengthened and an extra joint placed on the upper end of the delivery pipe. A single steam pipe down the shaft supplies both the sinking pump and the main pump. Electric sinking pumps are operated by electricity generated in a surface power plant.

Stamp mill: A mill for reducing ores to a comminuted state preparatory to extracting the precious metals by amalgamation. Stamps may be divided into three classes: Steam stamps, pneumatic and spring stamps, and gravity stamps. In the first-named class the pestles are raised and forced down by a steam piston. In pneumatic and spring stamps the power for lifting and forcing down the stamp is applied by a crank, while the shock to the machine and the variation of length of stroke are taken up by an air cushion or by a spring. The pestles of a gravity stamp are raised by power and fall by their own weight.

Steam drill: See Drill.

Steam pump: Force pump operated by steam acting upon the piston of a steam engine directly connected to the pump.

Steam stamp: See Stamp mill.

Trommel: A revolving screen, usually cylindrical in shape, in which ore is screened by causing it to slide by the revolution of the screen instead of a shaking movement. Tandem trommels have screens of two or more sizes on the same shaft, forming one continuous cylindrical or conical surface. Concentric trommels have two or more screens placed one outside of the other on the same shafts.

Undercutting machine: Machine for undercutting coal in the mine. See, also, Pick machine; Chain cutter machine, etc.

Vanner: A machine for separating heavy minerals from lighter by gently shaking or vanning, the mild agitation keeping the particles of the lighter mineral in suspension while the particles of the heavier mineral sink to the bottom.

Ventilating fan: A blower or ventilator for supplying air to mines.

XVII.

QUANTITY AND VALUE OF PRODUCTS.

Scope of the statistics.—For census purposes the productive industries of the country are divided into four broad groups—agriculture, manufactures, mining, and fisheries. It has been the endeavor since 1870 to preserve the distinction between these groups, but the trend of industrial development has been toward the consolidation of interests so as to bring under one management the production of both the raw material and the finished product. This tendency is especially noticeable in mining and manufacturing, and has caused these industries to overlap at many points, making a statistical separation impossible. The relationship between the two industries is discussed on page 9. It is evident that the difficulties attending a separation are increasing with the development of the resources of the country. If both industries were enumerated at the same time, it would be possible to so word the schedule as to obtain a consistent report covering the entire operations and at the same time make a practicable separation of the statistics. On the other hand, mines and quarries are a branch of the extractive industries, which include all those industries dealing in the natural products of the earth and are, in theory at least, allied to agriculture, but the statistics of agriculture for the Twelfth Census do not include any data relating to mines or quarries.[1]

The limitations of the statistics for manufactures are not so easily defined. Section 7 of the act of Congress of March 3, 1899, providing for the Twelfth and subsequent censuses, confined the inquiry to "manufacturing and mechanical establishments." If the law had not contained special provision for a mining census, this section would in all probability have been construed to cover mines and quarries, as was done in early censuses. In the absence of a direct provision of law, the limitation of the census of manufactures was not fixed arbitrarily, but was determined by the conditions and requirements of those industries which are on the border line between mining and manufacturing. This has resulted in some duplication in the statistics of production. For instance, an establishment engaged in the manufacture of cement that operated a quarry from which it obtained the raw material was reported as a manufactory, but it was also reported in the mining census as a quarry.

The two industries being thus interdependent, the duplication incident to the combination of their products can be eliminated only by ascertaining the quantity and value of the mining products consumed in manufacture. This was attempted at the Twelfth Census by obtaining from manufacturers the cost of materials purchased in a raw state.

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[1] Twelfth Census, Report on Agriculture, Part I, pages xiii and xiv.

Standard of measurement.—In statistics of manufactures the standard of measurement is limited to the dollar because of the great diversity of products and the impossibility of obtaining a uniform unit of quantity. For similar reasons the same unit of measurement is used in presenting the total for all mining products. The quantity is a more exact indication of the relative importance of a given product than is its value, and the quantity is shown for the majority of the minerals; but the impossibility of applying this standard is found when an attempt is made to reduce the different units to a uniform basis and give to each its true weight. For instance, there were 35,567,410 long tons of iron ore, 36,940,710 long tons of anthracite coal, 260,216,844 short tons of bituminous coal, 59,557,715 ounces of gold and silver, 34,291 flasks of quicksilver, and 89,275,302 barrels of petroleum reported as produced in the United States during the year 1902. These various units can not be reduced to a uniform basis, and the aggregate value is necessarily used in presenting the total. The value of the annual production of gold and silver was almost half as great as that of anthracite and bituminous coal, but there were nearly ten times as many wage-earners employed in the production of coal as in the production of the precious metals.

The changes in value per unit have resulted in a decrease in the total value of certain products, although the quantity has increased, while for others the percentage of increase in the total value has exceeded that of the total quantity. By the use of the quantity the uncertainties due to fluctuation in prices are eliminated. Table 58, which shows the production and commercial value of silver for selected years, as computed by the Director of the Mint, illustrates, for two periods, the increase in quantity accompanied by a decrease in value, and for three periods, the increase in quantity accompanied by a smaller increase in value.

TABLE 58.—*Production and commercial value of silver.*

YEAR.	FINE OUNCES.		COMMERCIAL VALUE.	
	Number.	Per cent of increase.	Amount.	Per cent of increase.
1880	30,320,000		$34,720,000	
1885	39,910,000		42,500,000	
Difference	9,590,000	31.6	7,780,000	22.4
1886	39,440,000		39,230,000	
1892	63,500,000		55,563,000	
Difference	24,060,000	61.0	16,333,000	41.6
1890	54,500,000		57,225,000	
1891	58,330,000		57,630,000	
Difference	3,830,000	7.0	405,000	0.7
1894	49,500,000		31,422,000	
1902	55,500,000		29,415,000	
Difference	6,000,000	12.1	[1]2,007,000	[1]6.4
1901	55,214,000		33,128,000	
1902	55,500,000		29,415,000	
Difference	286,000	0.5	[1]3,713,000	[1]11.2

[1] Decrease.

For three of the periods shown in the above table the percentage of increase in the quantity of silver produced exceeded the increase in commercial value, and for two there was an absolute decrease in value with a small rate of increase in quantity. The greatest difference is shown for the period from 1894 to 1902. The production for 1902 showed an increase of 6,000,000 ounces, or 12.1 per cent over the production of 1894, while the commercial value decreased by $2,007,000, or 6.4 per cent. There was also a decrease of $3,713,000, or 11.2 per cent, in the value reported for 1902 as compared with 1901, although the production increased by 286,000 fine ounces, or five-tenths of 1 per cent.

While in the case of silver the production has increased more rapidly than the value, the reverse is true for coal, the value having increased more rapidly than the production. This is shown by the following table, giving the quantity, value, and percentage of increase in the production of anthracite and bituminous coal:

TABLE 59.—PRODUCTION OF ANTHRACITE AND BITUMINOUS COAL.[1]

YEAR.	QUANTITY.		VALUE.		AVERAGE PRICE PER TON.		AVERAGE NUMBER OF EMPLOYEES.	
	Short tons.	Per cent of increase.	Amount.	Per cent of increase.	Amount.	Per cent of increase.	Number.	Per cent of increase.
1891	117,901,238		$117,188,400		$0.994		205,803	
1892	179,329,071		207,566,381		1.160		341,943	
Difference	61,427,833	52.1	90,377,981	77.1	0.166	16.7	136,140	66.2
1898	219,976,267		208,023,250		0.95		401,221	
1899	253,741,192		256,094,234		1.01		410,635	
Difference	33,764,925	15.3	48,070,984	23.1	0.06	6.3	9,414	2.3
1898	219,976,267		208,023,250		0.95		401,221	
1902	301,590,439		367,032,069		1.22		518,197	
Difference	81,614,172	37.1	159,008,819	76.4	0.27	28.4	116,976	29.2

[1] United States Geological Survey, "Mineral Resources of the United States," 1902.

The per cent of increase in the value of the production of coal for each of the periods covered by the above statement was greatly in excess of the percentage of increase in production and in the number of employees engaged in the industry. The production for 1902, as compared with 1898, increased by 81,614,172 short tons, or 37.1 per cent, while the value increased $159,008,819, or 76.4 per cent, the average value per ton increasing 27 cents, or 28.4 per cent, and the number of employees 116,976, or 29.2 per cent.

The increase in value does not convey a correct idea of the importance of the industry from the standpoint of employment, but there is a close affinity between the quantity of the product and the number of wage-earners. The production of a mine depends upon the thickness of the vein; the purity of the ore; the ease of working, as influenced, for example, by the necessity for drainage; the ability and energy of the superintendent and bosses; and the state of the labor market and the character of the laborers. All of these factors influence the cost of production, which also depends upon the price of supplies, the freight charges of transportation companies, and the character of the financial management.

Value of products for 1902.—The value of product reported at the census of 1902 was the value f. o. b. at the mine or quarry of all mineral or stone mined during the year. A similar value was given for the production of petroleum, but for natural gas the value reported was the price to the consumer as obtained from the books of the companies. The total value of products for all mines, quarries, and wells amounted to $796,826,417. As explained on pages 9 and 10, in some instances this value includes products that have been subjected to manufacturing processes carried on at the mine or quarry. It is the amount received by the operators of the mines or quarries and should not be confused with the value of the metallic contents of ores, such as refined gold and silver or fine lead, which are sometimes classed as a part of the value of the mineral products of the country. The total value of the commercial mineral production reported by the United States Geological Survey amounted to $1,260,637,415 for the year 1902. The difference between this value and the census value is explained on pages 129 to 131.

The value of the products reported at the census of 1902 is shown for each of the different classes of minerals, and these classes are also grouped in order to bring together the products of a similar character or of which similar uses are made. In all cases where the quantity of the product could be reported it is presented in connection with its value, and the statistics are discussed in detail in the separate reports for each mineral. The salaries, wages, and expenses reported for each mineral cover the development work carried on during the year at productive mines, and their sum for some mines necessarily exceeds the value of the products. In the natural gas industry the expenses incident to distribution are charged to the state in which they were incurred, while the value is reported for the state from which the product was obtained. For these and other reasons the expenses should not be considered as indicating the cost of the product, nor the difference between the total expenses and the value of the product as the profit of mining operations.

The statistics of production are discussed in detail in the separate reports for the different minerals and also in the presentation by states.

The following statement shows the value of the products for all minerals grouped according to their character or uses and the percentage that each group is of the total:

Value of products for groups of minerals and percentage each is of the total: 1902.

GROUP.	PRODUCTS	
	Value.	Per cent of total.
Total	$796,826,417	100.0
Metallic	215,453,587	27.0
Fuel	469,297,671	58.9
Structural materials	96,370,559	12.1
Abrasive materials	1,177,711	0.2
Chemical materials	10,618,669	1.3
Pigments	664,039	0.1
Miscellaneous	3,244,181	0.4

Of the $796,826,417 reported as the value of products of mines, quarries, and wells, $469,297,671, or 58.9 per cent, is included in the group of "fuels," composed of coal, petroleum, and natural gas. The production for the "metallic" group, which includes copper ore, gold and silver, iron ore, lead and zinc ore, manganese ore, and quicksilver, was valued at $215,453,587, or 27 per cent. The structural materials, comprising stone, cement, clay, and slate, were valued at $96,370,559, or 12.1 per cent. All other substances obtained from mines and quarries were valued at $15,704,600, or 2 per cent of the total. It appears, therefore, that the mineral products of the country are composed very largely of fuels and metallic ores, these two groups forming 85.9 per cent of the total.

The proportions of the total value of the products obtained from the mines and quarries in different geographic divisions of the United States are shown by the following statement:

Value of products by geographic divisions: 1902.

DIVISION	Value of products.	Per cent of total.
United States	[1] $796,826,417	100.0
North Atlantic	274,436,816	34.4
South Atlantic	71,571,074	9.0
North Central	251,874,635	31.6
South Central	50,044,485	6.3
Western	[1] 148,899,409	18.7

[1] Includes value of Alaskan coal and Hawaiian stone products.

The North Atlantic and the North Central states cover the principal mineral producing sections of the country. The value of the products of the two divisions amounted to $526,311,451, or 66 per cent of the total for the United States. Of the $274,436,816 reported as the value of products for the North Atlantic states, $236,871,417, or 86.3 per cent, was obtained from the mines, quarries, and wells of the state of Pennsylvania. The products of this state were composed very largely of coal, petroleum, and natural gas. Fuels were also the predominating minerals in the North Central division, their production amounting to $132,031,098, or 52.4 per cent of the total.

The value of the production of the Western states was only 18.7 per cent of the total for the United States. The chief products were gold and silver, copper ore, and lead and zinc ore, the production of these minerals amounting to $107,841,021 in value, or 72.4 per cent of the total for this division.

The value of the production of the South Atlantic and South Central states amounted to $121,615,557, or 15.3 per cent of the total for the United States.

Value per unit of measure.—The great variety of minerals included in the census reports and the wide variation in the value of products restricts the use of figures in ascertaining the average value per ton or other unit of production, there being comparatively few minerals for which the census statistics can be used for this purpose. This is illustrated by the following comparative table, presenting the quantity, value, and average value per unit of measure for selected minerals:

TABLE 60.—COMPARATIVE SUMMARY OF QUANTITY, VALUE, AND AVERAGE VALUE PER UNIT OF MEASURE OF PRODUCTS FOR SELECTED MINERALS: 1902 AND 1889.

MINERAL.	1902			1889		
	Quantity (short tons).	Value.	Average value per unit of measure.	Quantity (short tons).	Value.	Average value per unit of measure.
Asbestos	2,505	$46,200	$18.44	30	$1,800	$60.00
Asphaltum and bituminous rock	66,238	236,728	3.57	51,735	171,537	3.32
Barytes	61,668	203,154	3.29	21,460	106,313	4.95
Borax	19,142	2,383,614	124.52	[1] 4,000	[1] 500,000	125.00
Buhrstones and millstones	[2] 6,667	59,808	8.97	(3)	35,155	....
Cement	[4] 24,653,360	24,268,338	0.98	[1, 4] 7,000,000	[1] 5,000,000	0.71
Clay	1,455,357	2,061,072	1.42	[1] 329,665	[1] 635,578	1.93
Coal, anthracite	[5] 36,940,710	76,173,586	2.06	[5] 40,714,721	65,879,514	1.62
Coal, bituminous	260,216,844	290,858,483	1.12	95,629,026	94,346,809	0.99
Copper[6]	[7] 659,033,302	71,192,014	0.11	[7] 231,246,214	26,907,809	0.12
Corundum and emery	4,251	104,605	24.61	2,245	105,565	47.02
Crystalline quartz	15,104	43,085	2.85	(3)	(3)	....
Feldspar	45,287	250,424	5.53	[1] 7,808	[1] 39,370	5.04
Flint	36,365	144,209	3.97	[1] 12,447	[1] 49,137	3.95
Fluorspar	48,818	275,682	5.65	9,500	45,835	4.82
Fuller's earth	11,492	98,144	8.54	(3)	(3)	....
Garnet	3,926	132,820	33.83	(3)	(3)	....
Gold, coining value[8]	[9] 3,242,039	67,018,890	20.67	[9] 1,590,869	32,886,744	20.67
Graphite	27,438	227,508	8.29	7,003	72,662	10.38
Grindstones and pulpstones	55,657	667,431	11.99	(3)	439,587	....
Gypsum	[10] 681,633	2,089,341	3.07	[10] 257,769	764,118	2.95
Infusorial earth, tripoli, and pumice	6,415	55,994	8.73	3,466	23,372	6.74
Iron ore	[5] 35,567,410	65,465,321	1.84	[5] 14,518,041	33,351,978	2.30
Lead ore[11]	338,125	18,181,013	53.77	181,141	6,467,137	35.70
Lithium ore	1,245	25,750	20.68	(3)	(3)	....
Manganese ore	[5] 16,477	177,911	10.80	[5] 24,197	240,559	9.94
Marl	12,439	12,741	1.02	156,265	63,956	0.41
Mica, sheet	[7] 373,266	83,843	0.22	[7] 49,500	[12] 52,450	....
Mica, scrap and waste	1,400	35,006	25.00	196		
Mineral pigments, crude	35,479	360,885	10.17	[13] 38,184	[13] 483,766	12.67
Monazite	[7] 802,000	64,160	0.08	(3)	(3)	....
Oilstones, whetstones, and scythestones	3,876	113,968	29.40	2,991	32,980	11.03
Petroleum	[4] 89,275,302	71,397,739	0.80	[4] 35,163,513	26,963,340	0.77
Phosphate rock	[5] 1,548,720	4,922,943	3.18	[5] 550,245	2,937,776	5.34
Platinum and iridium	[9] 94	1,814	19.30	[9] 500	2,000	4.00
Quicksilver, crude	11,727	82,242	7.01	2,750	(3)	....
Quicksilver, refined	[14] 34,291	1,467,848	42.81	[14] 26,484	1,190,500	44.95
Silica sand	445,903	421,299	0.94	(3)	(3)	....
Silver, coining value	[9] 54,198,344	70,074,625	1.29	[9] 51,354,851	66,396,988	1.29
Sulphur and pyrite	[5] 207,874	947,089	4.56	[5] 94,782	209,990	2.22
Talc and soapstone	97,563	1,138,167	11.67	36,461	475,878	13.05
Tungsten	184	5,975	32.47	(3)	(3)	....
Uranium and vanadium	3,810	48,125	12.63	(3)	(3)	....
Zinc ore[15]	527,121	9,006,361	17.09	234,583	3,049,799	13.01

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[1] Not included as part of the census, no statistics other than production reported.

[2] Stones.

[3] Not reported.

[4] Barrels.

[5] Long tons.

[6] Copper contents of all ores mined.

[7] Pounds.

[8] Fine gold contents of auriferous ores and placer bullion.

[9] Troy ounces.

[10] Includes land plaster, calcined plaster, and crude gypsum.

[11] Nonargentiferous lead ore and lead contents of argentiferous and copper ores.

[12] Values not separable in 1889.

[13] Includes slate ground as a pigment, 2,000 long tons, value $20,000.

[14] Flasks.

[15] Zinc ore and zinc contents of auriferous and argentiferous ores.

While, with a few notable exceptions, the average values per unit for the minerals included in the above table indicate a general increase in 1902 as compared with 1889, the averages should not be accepted as reflecting the actual conditions. As explained on pages 8 and 9, the products were not reported at the two censuses on a uniform basis. The theory of both censuses was evidently to report, as a rule, the crude products, but in a number of cases refined or partially refined products were necessarily included. It is impossible to determine the exact extent to which the partially manufactured product has been included in the totals for either census. The quantities and value of coal, iron ore, petroleum, and other minerals for which a crude product is necessarily reported, or of buhrstones, millstones, oilstones, cement, and other substances reported in a manufactured or partially manufactured state may be accepted as a basis for computing the average value, although these values are in every instance the value f. o. b. at the mine and include different grades of a general class or group. For instance, different varieties of cement and different grades of the same variety are included in the totals for both censuses; therefore an average price obtained from such a combination has little significance. Where practicable the average value per unit is given in the reports on the separate minerals.

By-products. In adopting the classification of minerals used by the United States Geological Survey it was necessary to assign to certain classes products obtained from mines or quarries reported under other classifications. The class of products included in the totals for each mineral are described in the separate reports and also in the discussion of "classification," pages 24 to 35. This method of assigning the products found the widest application in the group of "abrasive materials." Of the total value—$1,177,711, reported for this group of minerals—$444,539, or 37.7 per cent, represents products obtained from quarries included in other classifications and under which the statistics for employees and wages and expenses are shown.

In four of the classes of materials included under abrasives a portion of the products was obtained from quarries included under other classes of minerals. Of the $667,431 reported as the value of grindstones and pulpstones, $403,066, or 60.4 per cent, was obtained from quarries included under the classification of "sandstones and quartzites." This value, $403,066, should therefore be added to the classification of sandstones and quartzites in order to obtain a value consistent with the salaries, wages, and other expenses.

The following statement shows the quantity and value of each class of products included under abrasive materials and also the quantity and value of each class obtained from other classifications:

Abrasive materials and the quantity and value of such materials obtained from quarries included under other classifications: 1902.

ABRASIVE MATERIALS.	TOTAL ABRASIVE MATERIALS.		OBTAINED FROM QUARRIES CLASSIFIED AS—							
			Sandstones and quartzites.		Siliceous crystalline rocks.		Talc and soapstone.		Grindstones and pulpstones.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (stones).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Total		$1,177,711	35,880	$411,938	100	$1,425	175	$1,436	565	$29,740
Buhrstones and millstones	[1]8,667	59,808			100	1,425				
Corundum and emery	4,251	104,605								
Crystalline quartz	15,104	43,085								
Garnet	3,926	132,820								
Grindstones and pulpstones	55,657	667,431	35,700	403,066						
Infusorial earth, tripoli, and pumice	6,415	55,994					175	1,436		
Oilstones, whetstones, and scythestones	3,876	113,968	180	8,872					565	29,740

[1] Stones.

XVIII.

MINING OPERATIONS OF GOVERNMENTAL INSTITUTIONS.

In addition to the statistics for mines and quarries operated by private enterprise, the mining census includes the statistics for 3 quarries operated by the United States Government, 41 quarries and 79 natural-gas wells operated by city or town governments; also 2 coal mines, 1 iron mine, 35 natural-gas wells, and 18 quarries operated by penal or eleemosynary institutions. In order to preserve the distinction between the mining operations controlled by governmental institutions and those conducted by private enterprise the statistics for the former work are presented separately, and Table 61 summarizes the totals for the mines, quarries, and wells controlled by each of the four classes of governmental institutions.

TABLE 61.—SUMMARY, MINING OPERATIONS OF GOVERNMENTAL INSTITUTIONS: 1902.

CHARACTER.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	179	78	106	$67,661	484	$270,938	$29,184	38	$46,330	$200,909	$1,071,153
United States	3	3	9	6,155	73	39,699			1,060	16,530	80,353
Municipal	120	48	51	28,921	305	167,886	22,436	30	40,123	122,136	494,037
Penal	19	19	46	32,585	105	63,028	3,248		4,547	61,323	470,069
Eleemosynary	37	8			1	325	3,500	8	600	920	26,694

The wage-earners shown in Table 61 do not include the convicts in penitentiaries or the value of the work of such convicts when employed on contract, lease, or otherwise, nor do they include the number of inmates of eleemosynary institutions thus employed. The salaried officials reported were not engaged exclusively in the supervision of the mines and quarries. It is probable that most of them had other duties to perform in and about the institutions, and miscellaneous duties are also required to some extent of the wage-earners. The number of employees reported, therefore, should not be accepted as the number engaged exclusively in mining operations.

Federal and municipal quarries and wells.—Of the 179 quarries and wells operated by governmental institutions, 123 were controlled by the United States and by city or town governments, and the statistics for such mining operations are presented in Table 62.

TABLE 62.—MINES, QUARRIES, AND NATURAL-GAS WELLS OPERATED BY THE UNITED STATES AND CITY OR TOWN GOVERNMENTS: 1902.

	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	123	51	60	$35,076	378	$207,585	$22,436	30	$43,183	$138,736	$571,390
Limestones and dolomites	16	16	21	12,857	128	66,203			2,234	21,477	125,749
Illinois	4	4	7	3,800	49	27,406			806	12,512	78,037
Iowa	4	4	2	837	9	4,578				285	8,441
Kentucky	2	2	4	2,470	8	3,150				125	5,492
Maryland	1	1	1	540	3	900			24	80	919
Minnesota	2	2	4	3,625	35	18,540			180	7,000	11,676
New York	1	1	1	700	9	5,089			150	125	8,500
Tennessee	1	1	1	280	5	1,624			230	50	2,184
Wisconsin	1	1	1	605	10	4,916			844	1,000	7,500
Natural gas	79	11	9	5,900	12	7,404	22,436	30	37,201	67,574	205,262
Indiana	27	2	1	900	2	1,068	900	1	5,172	100	22,339
Kansas	21	5	2	2,000	2	936	1,593	13	908	9,014	46,353
Ohio	27	3	6	3,000	8	5,400	12,000	8	31,121	58,460	126,570
South Dakota	4	1					7,943	5			10,000
Sandstones and quartzites	4	4	8	3,664	45	26,080			873	5,385	19,094
Illinois	1	1							23	2	25
Kentucky	1	1	3	750	11	3,350				500	5,000
Massachusetts	2	2	5	2,914	34	22,730			850	4,883	14,069
Siliceous crystalline rocks	24	20	22	12,655	193	107,898			2,875	44,300	196,285
Connecticut	2	2	4	2,425	68	37,828			1,300	12,262	53,815
Massachusetts	19	15	16	8,771	109	61,738			1,575	29,857	128,385
Minnesota	1	1	1	679	10	6,405				1,703	10,285
North Carolina	1	1	1	780	4	1,250				288	2,700
Pennsylvania	1	1			2	677				190	1,100

The mining operations carried on by the United States and by municipal governments gave employment to 378 wage-earners, to whom $207,585 was paid in wages during the year. Of this number 366, receiving $200,181 in wages, were engaged in operating quarries, from which were obtained products used in the construction of public buildings and highways, dams, canals, etc. The products of these quarries were valued at $369,128. Of the 28 quarries operated by municipalities and engaged in quarrying siliceous crystalline rocks and sandstones and quartzites, 21 were located in Massachusetts, and their products were valued at $172,454, or 70.3 per cent of the total for all quarries of these classes. The municipal quarries in Massachusetts were engaged exclusively in the preparation of road material. There were 79 natural-gas wells operated by 11 municipalities, the gas, valued at $205,262, being used in the operation of electric light and power plants. The gas was also used for the illumination of public buildings, streets, and grounds, and in some instances, was sold to private consumers.

Penal institutions.—The United States Bureau of Labor has made two reports on convict labor.[1] From the latter of these reports, which was published in July, 1896, it appears that the practice of employing convicts in mines and quarries and in the dressing and preparation of stone for building purposes, or for the construction of highways, prevailed in a number of state penitentiaries. The value of such work for the year 1895 was reported at $1,578,905. Work of this character was also done to a considerable extent by the inmates of penal institutions, where the regulations are less rigorous than in state penitentiaries. The majority of the convicts thus employed were not engaged directly by the state, but were worked under a contract, lease, or other system, and therefore the value of their work reported to the Bureau of the Census would be included in the returns of mines and quarries operated by private enterprise and reported under the head of "contract work." The statistics for the 19 mines and quarries operated by penal institutions are presented in the following table:

TABLE 63.—MINES AND QUARRIES OPERATED BY PENAL INSTITUTIONS: 1902.

	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work, amount paid.	Miscellaneous expenses	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	19	19	46	$32,585	105	$63,028	$3,248	$4,547	$61,323	$470,069
Coal, bituminous	2	2	25	18,786	64	41,236		4,085	21,881	390,054
Kansas	1	1	20	15,120	2	1,900		1,581	7,200	126,530
Tennessee	1	1	5	3,666	62	39,336		2,504	14,681	263,524
Iron ore	1	1	5	3,423			3,248		32,440	4,336
Texas	1	1	5	3,423			3,248		32,440	4,336
Limestones and dolomites	11	11	11	6,272	26	12,552		462	3,203	38,231
Illinois	3	3	3	1,640	7	4,152			1,886	11,871
Iowa	1	1	2	1,200	9	5,400			297	8,653
Kentucky	3	3	2	732	10	3,000		212	720	7,086
Minnesota	1	1	3	1,800					100	2,943
New York	2	2	1	900				250		2,875
Ohio	1	1							200	4,843
Sandstones and quartzites	3	3	1	560	2	1,240			2,775	18,732
Colorado	1	1							50	5,000
Nevada	1	1							25	3,732
South Dakota	1	1	1	560	2	1,240			2,700	10,000
Siliceous crystalline rocks	2	2	4	3,544	13	8,000			1,024	18,716
Minnesota	1	1	3	2,644	13	8,000			705	13,464
Pennsylvania	1	1	1	900					319	5,252

The 105 wage-earners shown in Table 63 as engaged in the mines and quarries operated by penal institutions do not include the convicts thus employed. They represent only the number of guards or free labor necessarily employed in the supervision of the work or in the performance of duties that can not be intrusted to the inmates. The production of the quarries thus operated was utilized in the erection of new buildings, retaining walls or sidewalks, or was broken into riprap and macadam by the prisoners and used in the construction of highways.[1] The 2 coal mines operated by penal institutions gave employment to more than half of the salaried officials and wage-earners engaged in operating the mines and quarries controlled by such institutions. The coal mined was valued at $390,054, or 83 per cent of the total value of the production of all mines and quarries of this class.

Eleemosynary institutions.—The statistics for the 2 stone quarries and 35 natural gas wells operated by eleemosynary institutions are presented in Table 64.

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[1] Report of the United States Commissioner of Labor, 1886, and Bulletin of United States Department of Labor, July, 1896.

TABLE 64.—QUARRIES AND NATURAL-GAS WELLS OPERATED BY ELEEMOSYNARY INSTITUTIONS: 1902.

	Number of quarries or wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	37	8			1	$325	$3,500	8	$600	$920	$26,694
Limestones and dolomites	2	2								300	944
Ohio	1	1								100	324
Pennsylvania	1	1								200	620
Natural gas	35	6			1	325	3,500	8	600	620	25,750
California	2	1								120	5,800
Indiana	30	3			1	325	3,500	8	600	500	19,800
Ohio	3	2									150

XIX.

THE VERIFICATION OF THE MINING CENSUS.

Statistics of the mineral products of the country are collected by the Bureau of the Census, also by the United States Geological Survey and by the mine inspectors and geologists of different states. When the statistics compiled by these various offices relate to the same mineral and cover the same year as that covered by the Census reports there should be a certain degree of harmony in the results, but this is disturbed because various methods are followed in collecting and compiling the data, according to the object of the report. The statistics in some of the reports represent a year's production; in others they represent the product placed on the market during the year; in some they give the quantity and value of the crude material; and in others they show the quantity and value of the product partly manufactured or prepared for the market.

Comparison with Geological Survey.—The reports of the United States Geological Survey are published yearly and are harmonized with the reports for the preceding year, also with prior Census reports. An agreement between the statistics of the Survey and those of the Bureau of the Census was one of the objects of the cooperative work of the two offices in collecting the reports for the mining census of 1902. The quantity and value of the different minerals as compiled by the two offices are compared in the following table:

TABLE 65.—COMPARISON OF MINERALS AND MINERAL PRODUCTS REPORTED BY THE BUREAU OF THE CENSUS AND THE GEOLOGICAL SURVEY: 1902.

MINERAL OR MINERAL PRODUCT.	BUREAU OF THE CENSUS.		GEOLOGICAL SURVEY.	
	Short tons.	Value.	Short tons.	Value.
Antimony	(1)	(1)	3,561	$684,506
Asbestos	2,505	$16,200	[2]1,005	[3]16,200
Asphaltum and bituminous rock	66,248	296,728	[4]105,458	765,048
Barytes	61,668	203,154	61,668	203,154
Bauxite	[5]29,222	128,206	[5]29,222	128,206
Borax	19,142	2,383,614	[6]20,004	2,538,614
Buhrstones and millstones	[7]6,667	59,808	(8)	59,808
Cement	[9]24,655,300	24,268,338	[10]25,753,504	25,366,380
Clay	1,455,357	2,061,072	1,455,357	2,061,072
Coal, anthracite	[5]36,940,710	76,173,586	[5]36,940,710	76,173,586
Coal, bituminous	260,216,844	290,858,483	260,216,844	290,858,483
Copper	[11]659,083,392	71,192,014	[12]659,508,644	76,568,954
Corundum and emery	4,251	104,605	4,251	104,605
Crystalline quartz	15,104	83,085	15,104	[13]84,335
Feldspar	45,287	250,424	45,287	250,424
Flint	36,365	141,504	59,305	154,209
Fluorspar	48,818	275,682	[2]48,018	[3]271,832
Fuller's earth	11,492	98,144	11,492	98,144
Garnet	3,926	132,820	3,926	132,820
Gold, coining value	[14]3,242,033	67,018,890	3,870,000	80,000,000
Graphite, crystalline			[16]3,936,824	
Graphite, amorphous	27,438	227,208	[5]4,739	[17]182,108
Grindstones and pulpstones	56,667	667,431	(8)	667,431
Gypsum	681,625	2,082,341	[5]816,478	2,089,341
Infusorial earth, tripoli and pumice	6,415	55,394	6,365	53,244
Iron ore	[5]35,767,110	$65,465,321	[18]35,554,135	[13]$65,412,950
Lead ore	[19]288,125	18,181,013	[15]270,000	22,140,000
Lithium ore	1,245	25,750	1,245	25,750
Manganese ore	[5]16,477	177,911	[5]16,477	177,911
Marl	12,439	12,741	12,439	12,741
Mica, sheet	[16]373,266	83,843	[16]373,266	83,843
Mica, scrap and waste	1,400	35,006	1,400	35,006
Mineral pigments, crude	35,179	320,885	73,049	944,332
Monazite	[16]802,000	64,160	[16]802,000	64,160
Natural gas	(8)	30,867,863	(8)	30,867,668
Oilstones, whetstones, and scythestones	3,876	118,968	(8)	[20]221,762
Petroleum	[9]89,275,302	71,397,739	[9]88,766,916	71,178,910
Phosphate rock	[5]1,548,720	4,922,943	[2]1,490,314	[3]4,693,444
Platinum and iridium	(21)	(21)	[22]94	1,814
Precious stones	(8)	328,450	(8)	328,450
Quicksilver, crude	[23]11,727	[23]82,242	(24)	(24)
Quicksilver, refined	34,291	1,467,848	[25]34,291	1,467,848
Silica sand	[26]445,903	121,280	[26]943,135	807,797
Silver, coining value	[27]54,138,311	70,071,625	[27]55,500,000	71,757,575
Stone	(8)	[28]64,769,897	(8)	[29]64,559,099
Sulphur and pyrite	207,874	947,089	207,874	947,089
Talc and soapstone	97,563	1,138,167	[30]97,954	1,140,507
Tungsten	184	5,575	(24)	(24)
Uranium and vanadium	3,810	48,125	3,810	48,125
Zinc ore	[31]525,121	9,005,552	[15]156,927	14,625,596
All other minerals	[32]25,502	840,256	[33]18,823	[33]35,344

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[1] Not reported by the Bureau of the Census.

[2] Quantity marketed in 1902.

[3] Value of product marketed in 1902.

[4] Includes residual asphaltum product from petroleum refineries not reported by the Bureau of the Census.

[5] Long tons.

[6] Includes 862 short tons of boric acid valued at $155,000 not reported by the Bureau of the Census.

[7] Stones.

[8] Not reported.

[9] Barrels.

[10] Includes all manufactured cement. Bureau of the Census reports only cement manufactured at quarries.

[11] Pounds, copper contents of all ores mined.

[12] Quantity of refined metal, value at New York city.

[13] Survey reports value of product finished and marketed. Bureau of the Census reports value at quarry.

[14] Troy ounces. Fine gold contents of auriferous ores, and placer bullion exclusive of 403,730 ounces, valued at $8,345,800, estimated by the Director of the Mint as produced in Alaska.

[15] Quantity of refined metal.

[16] Pounds.

[17] Estimated as crude.

[18] Does not include 13,275 tons of manganiferous iron ore used in production of spiegeleisen.

[19] Nonargentiferous lead ore and lead contents of argentiferous ores and copper ores.

[20] Survey reports an added value of $102,794 for a product which was finished away from quarries.

[21] Not reported, entire production obtained in the refining of auriferous ores.

[22] Troy ounces. Quantity of refined metal. Value at San Francisco.

[23] Cinnabar mined, but not reduced.

[24] Not reported by the Geological Survey.

[25] Flasks. Quantity of refined metal. Value at San Francisco.

[26] Bureau of the Census statistics include only the sand produced in sandstone quarries by crushing the rock. The Geological Survey includes sand produced in sandstone quarries as well as glass sand obtained from banks.

[27] Troy ounces. Fine silver contents of argentiferous ores, and placer bullion, exclusive of 92,000 ounces, valued at $118,950, mined in Alaska.

[28] Includes value as follows: Limestones and dolomites (less value of iron flux), $25,170,549; marble, $5,044,182; sandstones and quartzites, $10,601,171; siliceous crystalline rocks, $18,257,944; slate, $5,696,051.

[29] Does not include limestone quarried for cement valued at $210,798.

[30] Includes 391 tons of soapstone, valued at $2,340, classified by the Bureau of the Census under mineral pigments, crude.

[31] Zinc ore and zinc contents of auriferous and argentiferous ores.

[32] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

[33] Includes chrome ore, magnesite, nickel (refined metal), cobalt oxide, and rutile. Does not include molybdenum.

As explained on page 24, in the reports for the Bureau of the Census, the different mines and quarries were classified according to their product of chief value. By this practice there was assigned to some classifications a production of ores which included several metals, and in order to compare the Census data with the reports of the Geological Survey, the total production of gold, silver, copper ore, and lead and zinc ore is given in the foregoing table, irrespective of the class of ore with which they were mined or from which they were obtained. The products, therefore, do not agree with the products shown elsewhere for the same class of minerals. For instance, the copper contents of all ores, as shown by Table 65, amounted to 639,033,392 pounds, valued at $71,192,014, but the products of the copper mines, classed as such by the Bureau of the Census, amounted to 11,780,064 short tons of ore, valued at $51,178,036. Notwithstanding the above arrangement the production of gold as reported by the Geological Survey exceeds that of the Census report by 627,961 ounces, valued at $12,981,110; and of silver by 1,301,656 ounces, valued at $1,682,950, both exclusive of Alaska; of copper by 20,475,252 pounds, valued at $5,376,940. This excess in the reports of the Geological Survey is due to the fact that the totals for the Bureau of the Census are based on the reports of the mine operators representing the production of the mines, while those for the Geological Survey are based on the reports of smelters and refineries, and show the amount of refined metal marketed during the year rather than the amount produced by the mines. The value of 1 ton of ore assaying 1 ounce of gold per ton may have been computed, in the settlement between the miner and the smelter, at the rate of $19 per ounce of fine gold contents, from which further deductions were made for treatment and freight, leaving to the miner perhaps not more than $10 net, whereas the value of 1 ounce of refined gold bullion would be reported by the United States Geological Survey as $20.67. The results of both offices are correct, one aiming to obtain the market value of the refined metal and the other the amount received by the miner for his operations during the year.

The production of lead and of zinc, as reported by the Bureau of the Census, exceeds that of the Geological Survey by 68,125 and 370,194 short tons, respectively, while the value of these metals as reported by the Geological Survey exceeds the value shown in the Census report by $3,958,987 and $5,619,235, respectively. This discrepancy is due also to the fact that the Geological Survey reports the quantity and value of the refined product, the crude product reported by the Bureau of the Census being of greater weight but less value.

That part of the difference which is due to the inclusion of manufactured products by the Survey, under the same or similar mining classifications as those of the Bureau of the Census, is illustrated by asphaltum and bituminous rock. The Bureau of the Census reports 39,220 short tons less than the Geological Survey; these are valued at $528,320, and are the residual asphaltum product of petroleum refineries, which the Bureau of the Census classifies as the result of manufacturing processes. The Bureau of the Census report for mineral pigments, crude, is another illustration. The Geological Survey reports instead mineral paints, which are a manufacture, and its statistics are for the manufactured product marketed, the excess over the Bureau of the Census report being 37,570 short tons, valued at $583,447.

Graphite affords an illustration of the difference due to reporting the production marketed instead of the production mined. The Bureau of the Census values, which are for the production mined, exceed those of the Geological Survey, which are for the production marketed, by $45,400.

All of the differences between the amounts and values reported by the two offices are explained in the footnotes to Table 65, but another illustration may be given. The Bureau of the Census shows no production of antimony, but the Geological Survey reports 3,561 short tons of this metal, valued at $634,506. There was no production of antimony from domestic antimonial ores during the year 1902, and the entire quantity reported by the Geological Survey was obtained from smelting foreign or domestic hard lead ores from regulus or metal or from antimonial ores imported. The production, therefore, has no direct connection with the operations at the mine and was omitted from the mining census.

In addition to the minerals enumerated in Table 65, the annual reports of the Geological Survey show the quantity and value of the following substances which are, for Census purposes, classed as manufactured products, and therefore omitted from the statistics of mining: Aluminum, bromine, coke, pig iron, salt, zinc white, and arsenious oxide. The Geological Survey also reports the production of brick clay, glass sand, and mineral waters. Brick clay is omitted from the mining census, as the manufacture of brick, with that of all other clay products, was reported in the census of manufactures. The value of the material was a constituent of the value of product, and this material was generally mined by the manufacturer. Glass sand is omitted because most of it is obtained from sand banks or from river beds, and such production was not considered as forming a part of the mining or quarrying operations of the country. Glass sand, when obtained from the crushing of sandstone incident to the quarrying of such stone, has been included in the Census report on stone under the classification of "silica sand." Mineral waters are omitted because it is impossible to make a complete enumeration of such waters, and there is very little, if any, labor incident to their production, the operations consisting entirely in bottling and otherwise making the product ready for the market.

In order to cover the total production of minerals of all classes, the Geological Survey also includes an "estimated value of mineral products unspecified." Beginning with 1889 the value of these miscellaneous minerals has been placed annually at $1,000,000. An estimate of this character was not attempted for the census of 1902, the production being confined to the quantities and values reported by the mine operators. With the exceptions indicated, all of which are due to the difference in the objects of the reports of the two offices, there is an exact agreement in the production of the different minerals as compiled by the Geological Survey and the Bureau of the Census.

Comparison with state reports.—While the state mine inspectors and geologists in a number of the states collected miscellaneous information concerning different minerals, the only uniform compilation of the production relates to anthracite and bituminous coal. The quantities of coal as reported by the Bureau of the Census and by the state officials in several of the principal producing states are shown in the following table:

TABLE 66.—*Yearly production of coal as reported by United States Census and state offices.*

STATE OR TERRITORY.	Bureau of the Census (short tons).	STATE REPORTS.	
		Short tons.	Year ending—
Colorado	7,401,343	7,522,923	Dec. 31, 1902
Illinois	32,939,373	30,021,300	June 30, 1902
Indian Territory	2,820,666	3,243,692	June 30, 1903
Iowa	5,904,766	6,195,734	June 30, 1903
Kansas	5,266,065	5,290,433	Dec. 31, 1902
Kentucky	6,766,984	6,429,419	Dec. 31, 1902
Michigan	964,718	869,228	Dec. 31, 1902
Missouri	3,890,154	4,063,572	Dec. 31, 1902
New Mexico	1,048,763	1,359,690	June 30, 1903
Ohio	23,519,894	23,929,267	Nov. 15, 1902
Pennsylvania—			
Bituminous	98,574,367	98,946,203	Dec. 31, 1902
Anthracite	[1] 36,940,710	[1] 36,911,554	Dec. 31, 1902
Washington	2,681,214	2,690,789	Dec. 31, 1902
West Virginia	24,570,826	23,359,083	June 30, 1902

[1] Long tons.

The production of coal, as reported by the Bureau of the Census, agrees exactly with the production as reported by the Geological Survey; and from the above table it appears that when the reports of the Bureau of the Census and the state officials cover the same year there is a substantial agreement in the quantities reported, the greatest variation being shown for Pennsylvania, where the production of bituminous coal as reported by the state exceeds that shown by the Bureau of the Census by 371,836 tons. A number of the state reports, however, cover the fiscal year ending June 30, while in one instance, Ohio, the report covers the year ending November 15, and no satisfactory comparison can be made with the Bureau of the Census returns.

In addition to statistics of the production of coal the state of Missouri collects information concerning the production of lead and zinc. The production of these metals, as reported by the state office for the year 1902, amounted to 126,831 and 234,903 tons, respectively, as compared with 124,537 and 240,057 tons, respectively, reported by the Bureau of the Census. This is a striking agreement in the quantities compiled by two entirely independent offices. The state of Idaho also collects information concerning the production of lead. The production for 1902, as reported by the state office, amounted to 119,223,000 pounds, as compared with 208,093,202 pounds reported by the Bureau of the Census, the census report exceeding that of the state by 88,870,202 pounds. The production of lead in Idaho is obtained entirely from silver-bearing lead ores, and the total quantity can not be definitely ascertained until the ores have been subjected to smelting processes. The quantities, therefore, were estimated. This fact, in connection with the fact that the reports for the state do not necessarily apply to the quantities obtained from the ores mined during the census year, probably accounts for the marked difference. The quantity of iron ore produced in the state of New Jersey during 1902, as reported by the geological survey of the state, amounted to 443,728 tons, as compared with 441,879 tons reported by the Bureau of the Census.

XX.

MINING AND MANUFACTURING.

The combination of mining and manufacturing by the use of the same capital, wages, expenses, etc., has been accentuated by the consolidation of industrial enterprises, and it is impossible, in many instances, to segregate the statistics so as to show the true totals for each branch of industry. If the statistics for mining and manufacturing were to be taken together it would be easy to find a common term for this union, and comparatively simple to show the aggregate figures; but such a combination would not be a compliance with the act of Congress of March 6, 1902, which provides for mines, mining, quarries, and minerals as a distinct class of census work. Theoretically a perfect mining census should terminate with the delivery of the ore or crude rock at the mine or quarry, but in many cases the employees work indiscriminately in both branches of industry and no value is placed on the ore as it leaves the mine. Where the milling, separating, washing, burning, calcining, or other forms of reduction or manufacture were performed at the mine or quarry, the census of mines for 1902 includes, as a rule, the employees and the expenses involved in the entire work of the establishment. But the absence of uniformity in this respect at prior censuses makes it impossible to prepare satisfactory comparative statistics for a number of the important minerals.

The Twelfth Census of manufactures includes in a number of instances the mining and quarrying operations which are incident to such manufacturing as the smelting and refining of ores, the manufacture of monuments, tombstones, etc. The statistics for the two branches of industry are therefore to some extent duplicated. The totals, however, are presented in the following table:

TABLE 67.—*Mining and manufactures: 1902 and 1900.*

	Total	Mining, 1902	Manufactures, 1900
Number of establishments	664,250	[1]151,516	512,734
Salaried officials, clerks, etc.:			
Number	435,876	38,128	397,748
Salaries	$443,873,380	$39,020,562	$404,852,818
Wage-earners:			
Average number	5,903,117	581,728	5,321,389
Wages	$2,700,537,970	$369,959,960	$2,330,578,010
Miscellaneous expenses	$1,100,680,624	$71,771,713	$1,028,908,911
Cost of supplies and materials	$7,484,805,885	$123,811,967	$7,360,993,918
Value of product	$13,836,105,983	$796,826,417	$13,039,279,566

[1] Number of mines, quarries, and wells.

The cessation of work in the anthracite coal industry for a number of months during 1902 tends to reduce the value of the statistics for the mining census as representing conditions during a normal year, but with this exception the totals may be accepted as showing the aggregate importance of the two industries during a period of twelve months and the proportion which each contributes to this aggregate. The table indicates that the kindred industries of mining and manufacturing, which include the mechanical industries, gave employment, on an average during the year to 6,338,993 persons, and paid $3,144,411,360 in salaries and wages. Of this total the salaried officials numbered 435,876, or 6.9 per cent, and the wage-earners 5,903,117, or 93.1 per cent. The mining industries contributed 9.8 per cent of the number and 13 per cent of the wages and salaries, respectively, and the manufacturing and mechanical industries 90.2 and 87 per cent, respectively. Of the $13,836,105,983 reported as the gross value of products, mining contributed 5.8 per cent and manufactures 94.2 per cent.

In a few of the basic industries it is possible to follow the production of the mine to the initiatory stage of its manufacture and to ascertain the quantity and value of the product after it has passed through the first manufacturing process; but the comparison of this quantity and value with the quantity and value of the mineral is apt to be misleading. The mineral materials consumed in manufactures are necessarily the result of mining processes carried on at a previous date, and often the manufactured product is composed of different minerals and other substances, some of which are the result of manufactures. For instance, the production of iron ore for 1902 was 35,567,410 long tons and of pig iron 17,821,307 long tons, indicating that each ton of pig iron required about two tons of iron ore, but it is probable that a large proportion of the pig iron was manufactured from iron ore mined during the preceding year and that a considerable proportion of the production mined during 1902 was not used in manufactures until after the expiration of that year. The production of pig iron consumed not only all of the iron ore, but a large proportion of the 39,604,007 short tons of coal from which 25,401,730 short tons of coke were produced, practically all being employed in blast furnaces. The industry also consumed the 11,878,675 long tons of limestone used for fluxing purposes, and large quantities of coal as fuel.

The raw materials reported at the Twelfth Census as consumed in manufactures amounted to $2,389,140,942. Of this total, $1,940,727,048, or 81.2 per cent, were obtained from the farm; $118,803,115, or 5 per cent, from the forest; $319,975,108, or 13.4 per cent, from the mine; and $9,635,671, or four-tenths of 1 per cent, from the sea.[1] These amounts represent the materials consumed during the year ending May 31, 1900, while the products for the mines and quarries, which products were valued at $796,826,417, were for the calendar year ending December 31, 1902. The two amounts, therefore, are not comparable. This lack of comparability is due not only to the fact that the two reports cover different periods, but also to the fact that the value of the products of the mines and quarries includes in many instances the value of finished products ready for consumption. For instance, the amount for the product of mines and quarries includes cement to the value of $24,268,338; finished slate products to the value of $5,696,051; buhrstones and millstones and other finished abrasives to the value of $841,207. It also includes considerable proportions of the products of marble, sandstones and quartzites, siliceous crystalline rocks, anthracite coal, natural gas, and other minerals which were either sold at the quarry as finished products or consumed in other establishments than those engaged in manufactures. But the cost of the materials obtained from the mine and consumed in manufactures does not include the cost of coal, natural gas, or petroleum used as fuel in manufactures. According to the Twelfth Census, all kinds of fuel consumed in manufacturing establishments cost $205,320,632, and there was also paid $10,986,353 for the rent of power and heat. A large proportion of this cost represents the products of mines.

While all manufactures depend upon the production of mines either for raw materials or machinery, the production of metals is the most striking illustration of this interdependence. Of the various metals, iron is the most important, and it is possible to show its production in connection with the production of the minerals upon which it depends. A presentation of this character is made in the following statement, which presents the total production for the United States:

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[1] Twelfth Census, Report on Manufactures, Part I, page cxxxv.

	1902 (long tons).	1889 (long tons).	Per cent of increase.
Iron ore	35,567,410	14,518,041	145.0
Coke[1]	[2]25,401,730	[2]10,258,022	147.6
Limestone flux[1]	12,139,248	6,318,000	92.1
Pig iron[1]	17,821,307	7,603,642	134.4

[1] United States Geological Survey, "Mineral Resources of the United States," 1902.

[2] Short tons.

The ratio of increase in the production of iron ore and pig iron during the period covered by the above statement was 145 per cent and 134.4 per cent, respectively. The production of coke increased 147.6 per cent, and of limestone used as fluxing material 92.1 per cent. The production of iron and steel was valued at $430,954,348 at the census of 1890, and at $803,968,273 at the census of 1900, an increase of $373,013,925, or 86.6 per cent. These industries are dependent upon the production of iron ore, and an increase in its production would necessarily be followed by a corresponding increase in their manufactures.

When the ore and fuel both exist in the same locality the corresponding manufactures naturally develop locally; this is well illustrated by the growth of iron manufactures in Alabama during the last two decades. Whereas at the census of 1880 Alabama ranked fifth in coke and eighteenth in iron and steel, in 1900 the state was second in coke production and sixth in iron and steel manufactures. The rapid growth of manufacturing industries is due to the utilization of the state's rich mineral resources, which were neglected in the earlier years of the century. The state possesses within its borders all the requisites for iron manufacture—iron ore, coking coal, and limestone for flux. The same is true of Colorado, which has developed greatly in coal and iron and the attendant manufacturing industries during the last decade. The following table shows the interdependent growth of the coal and iron and the allied manufactures in these states:

TABLE 68.—INTERDEPENDENT GROWTH IN THE MINING AND MANUFACTURES OF COAL AND IRON IN ALABAMA AND COLORADO: 1902 AND 1889.

	ALABAMA.			COLORADO.		
	1902	1889	Per cent of increase.	1902	1889	Per cent of increase.
Mine products:						
Iron ore, long tons	3,574,474	1,570,319	127.6	306,572	109,136	180.9
Coal, bituminous, short tons	10,354,570	3,572,983	189.8	7,401,343	2,544,144	190.9
Coke, short tons[1]	2,552,246	1,030,510	147.7	[2]1,003,398	187,638	434.7
Limestone flux for furnaces, long tons	[1]1,001,881	221,215	352.9	[1]402,735	46,296	769.9
Manufactures:						
Coke, value[1]	$8,300,638	$2,372,417	249.9	[2]$2,754,341	$648,479	328.0
Iron and steel, value	[5]$17,392,483	[4]$12,544,227	38.6	[5]$6,108,296	(³)	
Foundry and machine-shop products, value	[5]$5,482,441	[4]$2,195,913	149.7	[5]$3,986,915	[4]$1,792,619	122.4

[1] United States Geological survey, "Mineral Resources of the United States," 1902.

[2] Includes Utah.

[3] Not reported separately.

[4] For census year 1890.

[5] For census year 1900.

While a considerable portion of the bituminous coal was consumed in the manufacture of coke, large quantities were used as fuel in manufactures generally, and also in other industries; therefore, the increase in its production is not necessarily accompanied by a corresponding increase in the production of iron. It is also probable that a portion of the coal, coke, and limestone produced in these states was shipped out of the state for consumption in manufactures in other sections of the country. During the period of thirteen years covered by this table the quantity of iron ore, coal, coke, and fluxing material more than doubled in both states, and the value of iron and steel and foundry products indicates that there has been a very large increase in the metal industries, though the statistics for them cover a period of only ten years.

Economies of production in manufactures demand the proximity of raw material, and also of a market for the finished product, or convenient transportation facilities for either or both. In the endeavor to secure the benefits incident to the greatest number of these conditions, factories have been located in different sections of the country, according to the relative advantages to be obtained from proximity to materials, market, or transportation facilities. This localization of industries has been in some instances a gradual growth, as in the case of the manufactures in the New England states, and in others a rapid development, following the discovery of exceptional natural advantages, such as the coal and iron fields of western Pennsylvania and of Alabama. Considering the census of manufactures of 1900 and the mining census of 1902 as comparable, Table 69 shows the total value and the proportion of the products of the mines and manufactures in the different geographic divisions of the country.

TABLE 69.—VALUE OF MINE AND QUARRY PRODUCTS AND MANUFACTURES THEREOF, BY GEOGRAPHIC DIVISIONS.[1]

DIVISION	MINE AND QUARRY PRODUCTS: 1902						MANUFACTURES BASED ON MINE AND QUARRY PRODUCTS: 1900			
	All products.[2]	Per cent.	Fuels.	Per cent.	Metallic.	Per cent.	All mine and quarry products.	Per cent.	Metallic.	Per cent.
Total	$796,800,681	100.0	$469,278,623	100.0	$215,453,587	100.0	$3,726,042,340	100.0	$2,840,014,465	100.0
North Atlantic	274,436,816	34.4	213,701,645	45.5	4,481,483	2.1	2,077,290,940	55.7	1,572,873,315	55.4
South Atlantic	71,571,074	9.0	55,925,138	11.9	2,729,820	1.3	193,646,729	5.2	123,186,606	4.3
North Central	251,874,635	31.6	132,031,098	28.1	91,216,846	42.3	1,102,285,147	29.6	854,212,735	30.1
South Central	50,044,483	6.3	37,727,941	8.1	6,202,862	2.9	110,489,187	3.0	77,211,113	2.7
Western	148,873,673	18.7	29,892,801	6.4	110,823,676	51.4	242,300,040	6.5	212,580,664	7.5

[1] Exclusive of Alaska and Hawaii.

[2] Includes structural, abrasive, and chemical materials, pigments, and miscellaneous minerals in addition to fuels and metalliferous minerals.

The North Atlantic states produced only 2.1 per cent of the ores, but the value of fuel amounted to 45.5 per cent and of manufactures to more than half of the total for the United States, indicating a concentration of manufactures to obtain the advantages incident to a liberal supply of fuel and a ready market.

The North Central states produced ore valued at $91,216,846, or 42.3 per cent of the total value of the ores, but the value of the fuels and manufactured products formed only 28.1 per cent of the total value for the United States. This tends to show that the ores were not used where they were mined, and that the mine operators were forced to take advantage of the transportation facilities to supply materials for the factories in the North Atlantic states. Of the ores obtained in these states, a value of $68,932,294 represented iron and copper from the mines of northern Michigan and Minnesota. The largest part of the freight transportation on the Great Lakes is on account of these mines. Transportation facilities here play an important part, the iron ores of Lake Superior being transported to the south Lake ports and to the centers of cheap fuel and iron consumption.

The value, $110,823,676, or 51.4 per cent of the total shown for the ores in the Western states, was composed very largely of the value of precious metals and copper, these minerals forming 67.9 and 29.1 per cent, respectively, of the total for the geographic division. The refined metal obtained from both of these minerals was sent elsewhere for manufacture.

The freight movement on the Great Lakes for 1902, as shown by the receipts at the Lake ports, aggregated 54,074,729 tons.[1] Of this, iron ore and mineral tonnage (not including coal) was 27,898,424 tons and coal 8,256,117 tons, making a total of 36,154,541 tons for mine products. This was 66.9 per cent of all freight. The iron ore production of the upper Lake district, Michigan, Minnesota, and Wisconsin, was 27,056,861 tons, distributed as follows: Michigan, 11,135,215 tons; Minnesota, 15,137,650 tons; and Wisconsin, 783,996 tons. This was 76.1 per cent of the iron ore production of the United States. The copper shipments, though of great value, do not constitute a large tonnage item of the Lake traffic, as most of the ore is smelted at the mines and only the copper shipped. The copper product of northern Michigan for 1902 was 171,102,065 pounds, or 85,551 tons, but a large portion of this product was shipped as mineral to be smelted at Buffalo. The total copper shipments on the Great Lakes were 140,509 tons; this tonnage includes shipments of copper from the head of Lake Superior received from the West. The movement of iron ore on the Great Lakes is shown by the following table:

TABLE 70.—*Movement of iron ore on the Great Lakes: 1902.*

SHIPMENTS		RECEIPTS	
Ports.	Tons.	Ports.	Tons.
Total	26,676,626	Total	26,603,601
Lake Superior ports	21,258,455	Lake Michigan ports	3,656,171
Duluth, Minn.	5,694,841	Elk Rapids, Mich	39,875
Two Harbors, Minn	5,489,314	Fruitport, Mich	34,392
Ashland, Wis	3,560,213	Chicago, Ill	79,210
West Superior, Wis	4,047,518	South Chicago, Ill	3,250,052
Houghton, Mich	1,036	Milwaukee, Wis	252,652
Marquette, Mich	1,245,580	Lake Erie and connected ports	22,868,314
Presque Isle, Mich	1,289,950	Detroit, Mich	40,910
Lake Michigan ports	5,352,177	Ashtabula, Ohio	4,743,679
Escanaba, Mich	5,270,512	Cleveland, Ohio	4,929,279
Gladstone, Mich	82,110	Conneaut, Ohio	4,308,392
Manistique, Mich	2,092	Fairport Harbor, Ohio	1,488,992
Menominee, Mich	1,000	Huron, Ohio	461,796
Green Bay, Wis	1,436	Lorain, Ohio	1,435,092
Milwaukee, Wis	6,197	Sandusky, Ohio	164,355
All others	72,984	Toledo, Ohio	1,029,107
		Erie, Pa	1,782,857
		Buffalo, N. Y	2,247,193
		North Tonawanda, N. Y	207,673
		Tonawanda, N. Y	2,307
		All others	79,116

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[1] Department of Commerce and Labor, Bureau of Statistics, "Monthly Summary of Commerce and Finance of the United States," November 1 to February 28, 1902-3, page 1797.

The chief use in manufactures of the various products of mines and quarries, and the aggregate value of the minerals and the manufactured products, so far as they can be reported separately, are shown in the following table:

TABLE 71.—MINE AND QUARRY PRODUCTS AND THE CHIEF MANUFACTURING INDUSTRIES UTILIZING SAME.

MINE AND QUARRY PRODUCTS: 1902		MANUFACTURING INDUSTRIES: 1900	
Character	Value of product.	Character	Value of product.
Total			$5,464,345,521
Metallic:			
Copper ore	$51,178,036	Bells; brass; brass and copper, rolled; brass castings and finishings, brassware; bronze castings; copper smelting and refining; electrical apparatus and supplies.	346,396,879
Gold and silver	82,482,062	Gold and silver, leaf and foil, gold and silver, reducing and refining, not from the ore, jewelry, pens, gold; plated and Britannia ware, silversmithing; silverware, watch cases.	95,676,328
Iron ore	65,465,321	Cutlery and edge tools; files; firearms; foundry and machine shop products, gas and oil stoves; gas machines and meters; hardware; hardware, saddlery; horseshoes, factory product; iron and steel; iron and steel bolts, nuts, washers, rivets, doors and shutters, forgings, nails and spikes, wrought pipes; ironwork, architectural and ornamental; ordnance and ordnance stores, pens, steel; registers, car fare and cash; safes and vaults; saws, scales and balances, screws, machine and wood; sewing machines and attachments; springs, steel, car, and carriage; steam fittings and heating apparatus, stencils and brands; tin and terne plate, tools; typewriters and supplies; vault lights and ventilators; wire, wirework, including wire rope and cable.	1,796,190,968
Lead and zinc ore	14,690,177	Babbitt metal and solder; paints (pigments); galvanizing; lead, bar, pipe, and sheet lead, smelting and refining, type founding; zinc smelting and refining.	222,298,643
Manganese ore	177,911	Iron and steel industries; pottery and glass; chemical and paint industries	(1)
Quicksilver	1,530,000	Amalgamation, manufacture of mineral pigments, chemicals, etc	(1)
Fuels:			
Coal, anthracite	76,173,586	Fuel (manufactures): coke, gas, illuminating and heating; coal-tar products	317,961,880
Coal, bituminous	290,858,483		
Natural gas	30,867,863	Fuel and lighting; gas carbon	(1)
Petroleum	71,397,739	Petroleum, refining	123,929,384
Structural materials:			
Cement	24,268,338	Lime and cement	28,689,135
Clay	2,061,072	Brick and tile; crucibles, pottery, terra cotta and fireclay products	95,141,170
Limestones and dolomites	30,441,801	Lime (see cement); mantels, slate, marble, and marbleized; marble and stone work; monuments and tombstones; paving and paving materials; masonry, brick and stone, plastering and stuccowork.	368,968,899
Marble	5,044,182		
Sandstones and quartzites	10,691,171		
Siliceous crystalline rocks	18,257,944		
Slate	5,696,051		
Abrasive materials:			
Buhrstones and millstones	59,808	Millstones	75,922
Corundum and emery	104,605	Emery wheels	1,381,675
Crystalline quartz	43,085	Wood finishing and sandpaper	(1)
Garnet	132,820	Abrasives	(1)
Grindstones and pulpstones	667,431	Grindstones	1,088,909
Infusorial earth, tripoli, and pumice.	55,994	Cleansing and polishing preparations	(1)
Oilstones, whetstones, and scythe stones	115,968	Hones and whetstones	196,323
Chemical materials:			
Borax	2,383,614	Chemicals (boric acid); glass and pottery manufacture; terra cotta and fireclay products (pottery).	(1)
Fluorspar	275,682	Glass, flux for iron furnaces; chemicals	(1)
Gypsum	2,089,341	Plastering and stuccowork (plaster of Paris and wall and cement plaster)	(1)
Phosphate rock	4,922,943	Fertilizers (rock phosphates)	8,365,297
Sulphur and pyrite	947,089	Chemicals (sulphuric acid); explosives (gunpowder)	12,615,795
Pigments:			
Barytes	203,154	Chemicals, paints (pigments)	6,643,215
Mineral pigments, crude	360,885		
Miscellaneous:			
Asbestos	16,200	Fireproofing, heat insulating, and noncombustible manufactures	(1)
Asphaltum and bituminous rock	255,728	Chemicals, paints and varnish; electric wire insulation; paving and paving materials	(1)
Bauxite	128,206	Aluminum; chemicals	[2] 1,920,000
Chrome ore	(1)	Furnace linings, hardening steel, chemicals	(1)
Feldspar	250,424	Pottery and tiles; wood filler; scouring soaps, glass manufactures	(1)
Flint	114,299		
Fuller's earth	98,144	Petroleum refining (clarifying oil)	(1)
Graphite	227,508	Graphite and graphite refining (crucibles, stove polish, paint, foundry facings, lead pencils, lubricants)[1]	424,173
Lithium ore	25,750	Chemicals (medicinal)	(1)
Magnesite	(1)	Furnace lining	(1)
Marl	12,741	Fertilizer	(1)
Mica	118,849	Axle grease, electrical apparatus and supplies (insulation), heat insulation, wall papers	(1)
Molybdenum	(1)	Hardening steel; chemicals	(1)
Monazite	64,160	Chemicals (rare earth salts for incandescent filaments)	(1)
Nickel and cobalt		Nickel: Hardening steel; alloys; coinage; electroplating Cobalt: Chemicals	(1)
Precious stones	328,450	Lapidary work	5,786,281
Rutile		Hardening steel; coloring porcelain, manufacture of artificial teeth	(1)
Silica sand	421,289	Glass; furnace, engine, and building sand	(1)
Talc and soapstone	1,138,267	Slate: Hearthstones; furnace linings, etc. Fiber talc: Fireproof paints, electric insulation, heat insulation, furnace facings, lubricants, paper manufacture.	(1)
Tungsten	5,975	Hardening steel; chemicals	(1)
Uranium	48,125	Hardening steel; chemicals	(1)
Vanadium			

[1] Not reported separately.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902.

XXI.

EXPORTS AND IMPORTS OF MINERALS.

Exports.—While the development of the export trade has been one of the leading features of industrial progress in the United States, the vast majority of mineral products of the country are subjected to manufacturing processes before they are sent out of the country, and therefore the products of the mines and quarries, as reported to the Census, form a very small proportion of the exports. The total exports of domestic merchandise for 1902, exclusive of gold and silver and phosphate rock, amounted to $1,349,493,266, and the exports of the products of mines, including crude mineral oils, amounted to $33,327,517, or only 2.5 per cent. The coining value of gold and the commercial value of silver produced during 1902, as based on the Census reports, and the production of gold and silver in Alaska, as estimated by the Director of the Mint, amounted to $102,695,557. Exclusive of coin the coining value of gold and the commercial value of silver exported was $70,419,846, the exports amounting to 68.6 per cent of the production. The classification followed by the Bureau of Statistics in compiling the statistics of exports does not correspond exactly with the classification of minerals adopted for the census of 1902. Their figures, however, may be used for the purpose of indicating the approximate amount of crude minerals exported. The following table presents the value of the exports of domestic merchandise, exclusive of gold and silver and phosphate rock, and the ratio of the exports of the products of mines to the total exports for each year from 1889 to 1902:

TABLE 72.—*Exports of domestic merchandise and products of mines, exclusive of gold and silver and phosphate rock: 1889 to 1902.*

[Compiled from annual reports of the Bureau of Statistics, on Commerce and Navigation of the United States, year ending June 30.]

YEAR ENDING JUNE 30—	Value of exports of domestic merchandise.	Value of exports of products of the mines, including crude mineral oils.	Per cent of products of mines to total exports.
1902	$1,349,493,266	$33,327,517	2.47
1901	1,455,414,413	34,159,482	2.35
1900	1,364,387,204	31,467,375	2.31
1899	1,197,941,331	22,166,283	1.85
1898	1,205,932,079	19,410,707	1.61
1897	1,027,001,674	20,804,573	2.03
1896	858,799,894	20,015,654	2.33
1895	787,651,337	18,509,811	2.35
1894	864,019,713	20,401,819	2.36
1893	826,877,918	19,794,502	2.39
1892	1,013,035,566	20,655,860	2.04
1891	870,051,407	22,020,428	2.53
1890	841,701,171	20,283,779	2.41
1889	729,213,079	19,866,557	2.72

The value of the exported products of mines has formed such a small proportion of the total exports that the statistics are instructive only in so far as they show the disposition of the different minerals. The following table presents the total value of each variety of the mining products, including crude petroleum oils, exported for each year since 1889:

TABLE 73.—VALUE OF EXPORTS OF PRODUCTS OF MINES, INCLUDING CRUDE MINERAL OILS: 1889 TO 1902.

[Compiled from annual reports of Bureau of Statistics, on Commerce and Navigation of the United States, year ending June 30.]

	1902	1901	1900	1899	1898	1897	1896
Total	$39,479,332	$39,815,162	$38,077,015	$28,197,101	$24,014,670	$26,972,992	$25,225,042
Clay	153,164	148,461	166,885	120,306	63,434	24,810	19,731
Coal, anthracite	7,117,809	8,125,803	7,364,088	6,475,596	5,906,171	5,678,198	5,717,246
Coal, bituminous	13,647,672	13,891,693	11,908,725	7,185,432	5,777,578	5,330,145	4,928,816
Copper ore	2,601,697	1,346,707	1,009,288	440,775	821,165	2,059,779	2,033,858
Iron ore	178,107	175,817	79,042	66,400	31,224	31,168	6,402
Marble and stone, unmanufactured	172,273	93,720	120,397	68,904	95,953	66,165	74,878
Nickel, oxide and matte	1,190,606	1,510,748	1,219,812	1,110,222	1,402,803	725,309	442,795
Oil, mineral, crude	6,084,848	6,686,929	7,364,162	5,202,802	4,343,292	6,171,862	6,121,836
Ore, gold and silver bearing	268,220	667,287	233,273	40,927	241,129	1,162,480	778,795
Phosphates, crude[2]	5,888,705	5,048,393	6,376,367	5,989,891	4,359,851	5,005,929	4,000,598
Quicksilver	425,728	400,298	556,142	516,459	414,958	448,333	628,673
Zinc, dross	369,811	164,140	224,210	367,976	104,898	40,544	17,713
Zinc ore	1,217,907	1,150,695	960,999	148,145	383,370	122,765	1,401
All other products of mining	167,945	164,711	243,675	163,377	129,971	101,706	52,302

	1895	1894	1893	1892	1891	1890	1889
Total	$24,625,294	$25,188,043	$23,947,309	$23,350,065	$24,257,244	$23,916,436	$20,936,087
Clay	21,193	29,880	25,072	23,653	26,857	19,552	18,113
Coal, anthracite	5,918,229	6,656,590	4,854,604	3,419,660	3,796,895	3,339,725	4,217,043
Coal, bituminous	5,180,398	5,252,375	5,149,534	5,229,498	4,304,531	3,756,362	2,474,176
Copper ore	1,104,515	2,435,716	4,591,358	6,036,777	7,260,893	6,053,295	7,518,258
Iron ore	6,000	(1)	(1)	(1)	(1)	(1)	32
Marble and stone, unmanufactured	83,359	142,691	153,428	169,777	191,520	252,516	116,998
Nickel, oxide and matte	316,638	493,964	145,047	370,974	(1)	(1)	(1)
Oil, mineral, crude	5,161,710	4,415,915	4,567,391	5,101,840	5,876,452	6,744,235	5,083,152
Ore, gold and silver bearing	371,218	146,779	225,524	39,325	34,542	1,973,976	80,561
Phosphates, crude[2]	5,741,282	5,038,445	3,927,548	2,667,120	2,182,274	1,618,681	988,509
Quicksilver	425,724	618,297	204,808	119,798	88,359	187,066	241,947
Zinc, dross	31,474	74,800	35,620	(1)	(1)	[3]31,897	(1)
Zinc ore	115	36	5,960	111,639	142,011	[4]182,980	25,354
All other products of mining	259,859	182,555	60,570	36,944	43,310	50,480	89,214

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[1] Not reported.

[2] Included in manufactures under the head of fertilizers, prior to 1899.

[3] Zinc ashes.

[4] Zinc, ore and oxide of.

With the exception of nickel and phosphate rock, the quantities exported formed only a small proportion of the mining products of the country. The value of the exports of nickel and phosphate rock in 1902 apparently exceeded the value of the total production of those minerals by $2,147,458. It is probable, therefore, that the classification adopted by the Bureau of Statistics included partially manufactured products, or other substances not included in the mining census, else the exports were composed in part of products mined during prior years.

The value of anthracite and bituminous coal formed more than a third of the value of the exports of the mining products in 1889 and in each year since. The $20,765,461 reported as the value of the coal exported in 1902 represents 6,971,184 tons; of this amount 4,732,185 tons, valued at $14,281,425, or 67.9 per cent of the quantity and 68.8 per cent of the value, were exported to Quebec, Ontario, Manitoba, etc.

Crude mineral oil was the next most important mineral product exported. There were 133,536,800 gallons of crude mineral oil exported during the year ending June 30, 1902, valued at $6,084,818. Of this total 89,733,032 gallons, valued at $4,272,144, or 67.2 per cent of the total quantity and 70.2 per cent of the value, were consigned to France; 10,844,913 gallons, valued at $550,694, were exported to Mexico; and 10,132,815 gallons, valued at $497,060, to Spain; leaving only 22,826,040 gallons, valued at $764,920, or 12.6 per cent, as the exports to all other countries.

Crude phosphate ranked third among the exports of mining products. The quantity exported for 1902 amounted to 747,672 tons, valued at $5,888,595. Of this total 372,035 tons, valued at $3,133,477, or 49.8 per cent of the quantity and 53.2 per cent of the value, were exported to the United Kingdom and Germany, and 375,637 tons, valued at $2,755,118, were exported to other countries.

There were 25,076 tons of copper ore exported, valued at $2,601,697; 13,875 tons, valued at $1,895,586, were consigned to the United Kingdom; and 11,139 tons, valued at $699,677, to Mexico, while only 62 tons, valued at $6,434, were shipped to other countries.

Imports.—The methods used in compiling the statistics of imports are also at variance with those followed by the census, and there are comparatively few products for which a satisfactory comparison of the imports and the production can be made, but the statistics for such products are presented in Table 74.

TABLE 74.—*Value of production and imports of certain comparable minerals: 1902.*

Imports compiled from reports of the Bureau of Statistics on Commerce and Navigation of the United States, year ending December 31.

MINERAL.	Production.	Imports for consumption.
Asbestos	$16,200	$762,432
Asphaltum and bituminous rock	256,728	192,658
Barytes	203,154	[1] 27,699
Bauxite	128,206	54,110
Borax	2,383,614	20,795
Buhrstones and millstones	59,808	16,158
Cement	24,268,338	2,566,101
Chrome ore	4,567	582,297
Clay	2,061,072	1,107,770
Coal, anthracite	76,173,586	792,409
Coal, bituminous	290,858,483	6,981,168
Copper ore	[2] 71,192,014	[3] 20,837,349
Corundum and emery	104,605	[4] 201,666
Flint	144,209	[5] 85,092
Gold and silver	[6] 92,911,013	[7] 55,088,883
Graphite	227,508	1,169,388
Grindstones and pulpstones	667,431	76,966
Gypsum	2,089,341	508,167
Infusorial earth, tripoli, and pumice	56,994	62,374
Iron ore	65,465,321	2,568,623
Lead and zinc	[8] 27,187,571	[9] 671,476
Magnesite	19,639	250,350
Marble	5,044,182	881,207
Mica	118,849	166,532
Mineral pigments, crude	369,885	195,868
Monazite	61,160	[10] 12
Natural gas	30,867,863	27,436
Nickel and cobalt	8,800	1,185,927
Oilstones, whetstones, and scythestones	113,968	56,456
Petroleum	71,397,730	176
Phosphate rock	4,922,943	388,479
Quicksilver	1,550,000	2,166
Stone, exclusive of marble	64,996,967	51,657
Sulphur and pyrite	947,089	1,907,842
Talc and soapstone	1,138,167	36,366
Tungsten	5,975	7,046

[1] Baryta, carbonate and sulphate.
[2] Commercial value for copper contents of all ores mined.
[3] Value of imports of ore, regulus and black, and bars, ingots, and pigs.
[4] Emery grains and rock.
[5] Flint and flint stones.
[6] Commercial value of gold and silver contained in auriferous ores and placer bullion.
[7] Imports less foreign exports. Commercial value of gold and silver in ore and base bullion and bullion refined.
[8] Includes values for lead and zinc produced in gold, silver, and copper mines.
[9] Lead ore, dross, pigs, and bars, and zinc, in blocks or pigs.
[10] Monazite sand and thorite.

The minerals enumerated have been selected because the classifications by which they were designated in compiling the statistics of imports compare most nearly with the classifications used in compiling the census reports, but they should not be accepted as representing all minerals imported. Bismuth and lithographic stone were not produced in commercial quantities in the United States, and the entire consumption was dependent upon the imports.

The imports for a number of the minerals shown in Table 74 exceeded the production for 1902, and the conditions prevailing for each of them are summarized as follows:

Asbestos.—Practically the entire amount of asbestos consumed in the United States has been obtained from Canada. The imports for consumption in 1902 amounted to $762,432, as compared with a domestic production of $46,200. Asbestos of suitable quality and in sufficient quantities to supply the demand has not been uncovered in this country.

Asphaltum and bituminous rock.—While there has been a growing increase in the production of asphaltum and bituminous rock in the United States, the value of the imports for consumption for 1902 exceeded the value of the domestic production by $255,930. The domestic production was crude material, and it is probable that the imports were of a more highly finished character. The material is obtained in an almost pure form from Pitch Lake, in the island of Trinidad, where the cost of production is reduced to a minimum. The quantity imported from this source during the year ending June 30, 1902, was valued at $329,819. The asphaltum imported from Barbados possesses peculiar qualities which make it especially adaptable for the manufacture of varnishes and the insulation of electric cables.

Chrome ore.—Practically all of the chrome ore consumed in the United States was imported. The deposits in the United States are not conveniently located for development and can not compete with the low price of the foreign ore.

Corundum and emery.—The value of the imports of corundum and emery was almost twice as great as the value of the domestic production. The excess of the imports over the production was due chiefly to the fact that the largest domestic deposits are not conveniently located for transportation facilities and can not compete with the large deposits of Canadian corundum that can be more conveniently worked; or the production of Turkish emery, which is produced at a considerably lower cost and imported into the United States as ballast. Artificial corundum, moreover, is also produced in large quantities and will undoubtedly affect the production of the natural material.

Graphite.—While graphite has been developed in a number of different localities throughout the United States, the production still falls far short of the demand, which has increased with the development of the mechanical and electrical industries. Graphite is also being successfully produced by artificial means. The imports, however, are still many times in excess of the domestic production.

Infusorial earth, tripoli, and pumice.—The value of the imports of these minerals exceeded the domestic production by $6,380. This increase was due entirely to the imports of pumice, for this mineral has been found and quarried in the United States in comparatively insignificant quantities. The imports were obtained almost entirely from the island of Lipari, north of Sicily, and were shipped largely as ballast.

Magnesite.—The entire domestic production of magnesite was obtained from mines in the state of California, which apparently are not able to supply the market. No other deposits appear to have been discovered. The imports were obtained almost entirely from Greece and Austria.

Mica.—While this mineral is found in a number of the states and exists in considerable quantities in different localities, the individual deposits have not been developed to a great extent, and the quality is inferior to that of the imported variety which is obtained largely from Canada and India. The good variety of mica obtained from the deposits in India and the cheap labor there enables it to be produced and delivered in the United States in sufficient quantities to almost entirely supply the market.

Nickel and cobalt.—Practically all of the nickel and cobalt consumed in the United States is obtained from Canada, where the deposits are extensive and cheaply mined. Both minerals have been found and mined in various localities in the United States, sometimes in connection with lead ore, but they have not been produced in quantities sufficient to supply the market, because, in part, of the moderate price which has prevailed for nickel.

Sulphur and pyrite.—The excess of the imports over the production of sulphur is not due apparently to its scarcity in the United States, but to the immense deposits of pure sulphur found in Sicily, which are worked by cheap labor. The imports of pyrite more than doubled the production.

Tungsten.—The imports of this mineral exceeded the comparatively small production by only $1,071. The domestic production has been obtained largely in connection with other minerals.

Of the other minerals enumerated in Table 74 the following show the largest amounts imported during the year 1902, the minerals being considered in the order in which they appear in the table.

Cement.—The production of cement reported by the census is confined to the manufacture of cement at and in connection with the operation of limestone quarries. The total production for 1902, as reported by the United States Geological Survey, was valued at $25,366,380. The imports, therefore, formed a comparatively small percentage of the total consumption. There were 423,844,160 pounds of Roman, Portland, and other hydraulic cement imported during the year ending June 30, 1902, and these were valued at $1,478,452. Of these imports 227,056,720 pounds, valued at $834,555, came from Germany; all other countries sent 196,787,440 pounds, or 46.4 per cent, of the quantity, valued at $643,897, or 43.6 per cent of the total.

Clay.—As shown by Table 74, the value of the clay imported for consumption was more than half as great as the value of the domestic production. Common blue clay, used for the manufacture of crucibles, was obtained very largely from Germany. The imports from that country for the year ending June 30, 1902, were valued at $59,492, as compared with $13,603 reported for all other countries. Other clay, including China clay, or kaolin, came largely from the United Kingdom and Germany, the imports from these countries amounting to $1,122,647, or 92.4 per cent of the total for other clay.

Coal.—While the imports of coal form a very small proportion of the consumption, nevertheless considerable quantities of bituminous coal were imported during the year 1902, the imports being stimulated to some extent by the shortage in the production of anthracite coal. The imports from British Columbia, Nova Scotia, and New Brunswick for the year ending June 30 were valued at $3,904,526, forming 73.5 per cent of the total imports. Including anthracite the imports from all other countries amounted to $1,407,882, or 26.5 per cent of the total.

Copper.—The imports for consumption of copper during the calendar year 1902 were valued at $20,537,349, the amount being about one-third as great as the production; this mineral is imported largely from Mexico. The imports from that country for the year ending June 30, 1902, were valued at $9,934,097, or 70.9 per cent of all copper imported.

Gold and silver.—Gold and silver ore and bullion is the most important class of imports, the amount—$55,688,883—reported for 1902 constituting 70.7 per cent of the total for the principal minerals imported, as shown by Table 74. Of this aggregate the value of gold was $32,582,221, or 41.4 per cent, and the value of silver was $23,106,662, or 29.3 per cent. Of the silver approximately 85 per cent was imported from Mexico. Of the gold about 30 per cent was obtained from Quebec, Ontario, etc., and about 27 per cent from Mexico.

Iron ore.—The imports for consumption of iron ore during the calendar year 1902 were valued at $2,558,023. Of the imports for the year ending June 30 iron ore valued at $1,109,205, or 46.9 per cent, was obtained from Cuba; a value of $677,131, or 28.7 per cent, from Quebec, Ontario, Manitoba, etc., and $406,662, or 17.2 per cent, from Spain.

Lead and zinc.—The imports of lead ores came almost entirely from Mexico and British Columbia, the amount received from these countries for the year ending June 30, 1902, being valued at $4,401,390, or 97.9 per cent of the total.

The value of the minerals imported during 1902 was more than twice as great as the value of the exports of similar products. In a number of instances the imports bear an important relationship to the consumption, and the statistics are worthy of more detailed consideration. To assist in such an analysis Table 75 is presented, which gives the value of all the minerals or mineral products, as classified by the Bureau of Statistics, that have been imported for consumption each year from 1889 to 1902. Some of them are not included in the preceding comparative table.

TABLE 75.—IMPORTS FOR

From reports of the Bureau of Statistics.

	MINERAL.	1902	1901	1900	1899
1	Agate, unmanufactured	$1,170	$940	$625	$195
2	Asbestos, manufactured	25,819	8,202	16,314	9,759
3	Asbestos, unmanufactured	752,125	437,733	292,879	296,508
4	Asphaltum or bitumen, crude	472,005	501,710	357,988	226,425
5	Asphaltum and bitumen, dried or advanced	38,760	42,613	43,196	18,557
6	Asphaltum, manufactures of	4,949	1,375	1,636	1,575
7	Asphaltum and bitumen, crude or dried				
8	Asphaltum and bitumen, limestone rock asphalt containing not more than 15 per cent of bitumen.	21,617	52,529	12,065	39,761
9	Baryta, carbonate of, or witherite	15,870	17,298	15,651	16,552
10	Baryta, sulphate of, or barytes, including barytes earth, unmanufactured	14,178	6,549	7,886	3,296
11	Bauxite or terra alba, aluminous	52,245	64,597	11,413	14,168
12	Brazilian pebble		697		577
13	Borax	26,865	18,291	5,060	2,755
14	Borax, refined				
15	Borax, borates of lime or soda or other borate material not otherwise provided for	10,740	7,491	3,761	24,903
16	Borax, borate of lime				
17	Borax, crude, or borate of soda				
18	Cement, Roman, Portland, and other hydraulic, in barrels, sacks, or other packages	1,443,900	2,164,556	3,191,897	2,691,313
19	Cement, Roman, Portland, and other hydraulic, other	32,776	71,928	17,537	43,785
20	Cement, Roman, Portland, and all other				
21	Cement, Portland, Roman, and other hydraulic, in bulk			6	
22	Chromate of iron or chromic ore	526,011	214,762	378,101	264,376
23	Clay, china clay or kaolin	849,314	701,780	694,280	599,650
24	Clay, common blue, in casks	78,100	67,763	111,762	76,014
25	Clay, unwrought or unmanufactured, not specially provided for	146,725	114,060	131,478	101,331
26	Clay, wrought or manufactured, not specially provided for	63,177	58,533	40,435	27,871
27	Clay, all other not specially provided for	13		136	62
28	Coal, anthracite	2,006	6	628	2,686
29	Coal, bituminous and shale	1,541,328	1,585,335	1,022,902	3,179,931
30	Coal, slack or culm, such as will pass through a half inch screen	757,392	787,515	440,046	109,331
31	Coal, coke	359,438	359,611	232,947	171,995
32	Cobalt and cobalt ore and zaffer	27,237	11,863	7,414	10,986
33	Cobalt, oxide of	137,959	111,740	72,072	67,442
34	Copper ore	2,756,487	2,944,791	1,039,352	608,399
35	Copper, regulus of, and black or coarse copper and copper cement	13,275,576	7,471,649	1,102,978	586,430
36	Emery ore	137,695	288,424	162,166	138,891
37	Emery, grains and ground, pulverized, refined, or manufactures of emery	55,870	30,509	28,324	28,168
38	Emery, grains and ground, pulverized or refined				
39	Emery, fillet				
40	Feldspar				
41	Fuller's earth, unwrought and unmanufactured	23,142	16,006	19,985	21,569
42	Fuller's earth, wrought or manufactured	68,160	55,450	41,523	54,772
43	Gold ore and bullion[1]	31,263,540	37,238,119	23,492,557	35,740,111
44	Hones and whetstones	59,617	51,333	40,128	30,916
45	Iridium	22,470	6,072	5,168	6,561
46	Iron ore, ores including manganiferous iron ore, also dross or residuum from burnt pyrites	2,383,123	1,131,765	1,497,715	403,298
47	Iron ore, basic slag	9,898	6,398	996	
48	Iron ore, all other ore				
49	Lead, lead-bearing ore of all kinds	224,476	247,627	167,367	185,872
50	Lead, base bullion	18,041	78,845	52,691	21,615
51	Lead contained in silver ore				
52	Lead contained in all other ore and dross				
53	Magnesite, crude or calcined, not purified (purified for 1902)	312,615	281,901	330,102	158,267
54	Magnesite, or native mineral carbonate of magnesia				
55	Manganese, ore and oxide of	1,784,120	1,163,971	2,685,211	856,478
56	Manganese, oxide of				
57	Manganese ore				
58	Mica, unmanufactured or rough trimmed only	361,430	501,740	263,472	182,278
59	Mica				
60	Mica, cut or trimmed	42,709	30,619	32,783	40,481
61	Mica and mica waste				
	Mineral paints:				
62	Brown, Spanish, Indian red, and colcothar or oxide of iron	67,112	66,252	72,860	56,484
63	Brown, Spanish, Indian red, and colcothar or oxide of iron, and Vandyke Cassel earth or Cassel brown.				
64	Brown, Vandyke Cassel earth or Cassel brown	311			
	Ocher and ochery earths, not specially provided for—				
65	Crude, not powdered, washed, or pulverized	149	777	6,423	1,155
66	Powdered, washed, or pulverized	104,156	61,381	63,278	65,686
67	Ocher and ochery earths, dry				
	Sienna and sienna earths, not specially provided for—				
68	Crude, not powdered, washed, or pulverized	10,265	3,777	890	3,489
69	Powdered, washed, or pulverized	13,480	8,878	26,192	7,724
70	Sienna and sienna earths, dry				
	Umber and umber earths, not specially provided for—				
71	Crude, not powdered, washed, or pulverized	6,427	8,103	8,727	1,488
72	Powdered, washed, or pulverized	1,373	5,103	1,176	5,216
73	Umber and umber earths, dry				
74	Minerals, crude, or not advanced in condition by refining or grinding or other process of manufacture, not specially provided for.	71,886	73,710	67,410	62,421
75	Minerals, not dutiable, advanced in value or condition by refining or grinding or other process of manufacture, not specially provided for.	14,690	5,482	21,087	18,893
76	Mineral substances in a crude state, not specially provided for				

[1] Imports less foreign exports.

CONSUMPTION: 1889 TO 1902.

[illegible]

1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	
$457	$17	$548	$9	$[illegible]	$6	$161	$109	$21	$156	1
8,753	6,808	21,514	16,718	12,449	7,971	50,284	8,066	4,946	11,755	2
201,616	101,861	244,427	280,909	148,088	251,892	320,279	268,408	249,980	260,316	3
227,802					240,006	288,40[illegible]	251,117	149,[illegible]	88,180	4
22,477										5
7,006	46,255	71,750	46,355	25,084	70,820	84,875	40,980			6
34,157	395,554	259,380	266,951	503,880						7
24,720										8
8,614	7,296	10,387	17,011	22,127	21,640	30,246	14,068	6,222	13,583	9
1,987	953	3,788	7,274	5,620	6,995	11,040	18,482	8,614	8,212	10
1,329	15,259	19,821	18,216	8,415			50,128	70,922	40,813	11
26	228	1,409	521	1,396	1,748	2,295	8,816	31,092	23,656	12
2,541										13
	249	796	26,420	226	1,327	420	1,062	275	685	14
4,912										15
27,714	154,250	104,951	87,255				8,631	800		16
			18,489	11,427	13,659	6	2,100			17
2,519,992	2,940,129	3,828,722	3,418,910	2,927,754	3,765,691	3,780,033	2,847,262			18
11,003	67,757	48,974	18,496	19,395	22,532	18,566	5,385			19
							1,123,362	2,171,350	1,459,876	20
										21
196,411	169,192	178,774	84,729	34,557	51,698	126,074	76,982	8,104	50,665	22
546,214	184,140	560,296	465,657	369,950	300,474	347,358	232,022	160,420	154,776	23
58,772	50,454	50,861	52,361	29,909	58,416	58,540	38,621			24
87,140	78,105	114,941	111,407	89,034	157,084	118,798	154,518	149,658	161,579	25
23,797	81,389	65,687	100,425	63,826	76,461	92,808	47,546	36,021	55,470	26
194										27
11,801	292,923	315,964	204,027	187,780	193,602	162,049	15,870	80,436	31,266	28
3,310,880	3,502,616	3,555,799	3,850,027	3,680,607	3,700,658	4,352,120	3,558,932	4,071,562	3,913,168	29
83,222	40,574	20,217	22,028	22,901	17,357	17,260	26,768	16,655	15,802	30
112,010	68,212	117,013	61,880	80,912	87,758	194,088	118,755	115,055	73,177	31
11,103	9,964	9,258	7,736	6,762	7,219	1,244	701	2	52	32
35,986	14,066	30,012	19,844	19,979	55,712	64,850	64,416	17,044	30,378	33
638,893	373,741	140,660	237,248	491,280	451,258	630,804	434,654	298,049	319,136	34
191,129	187,855	114,928	200,257	113,536	170,080	204,991	19,073	46,168	179	35
81,432	122,880	89,419	73,409	58,511	106,615	104,836	71,100	74,067	75,982	36
21,139	21,798	29,282	17,116							37
			1,758	15,736	26,022	29,104	26,615	16,532	21,625	38
170	30									39
3,565	17,206	6,561	3,648	1,751	3,465	2,685	1,538	1,771	120	40
26,560	22,081									41
48,715	48,732									42
31,280,488	17,364,617	15,418,667	13,158,073	15,013,910	14,661,106	11,559,457	2,245,765	2,451,808	1,160,171	43
37,910	20,667	4,973	20,841	25,146	28,042	29,862	4,112	35,627	29,080	44
3,071	7,225	1,[illegible]	328	958	1,390	2,753	386	102	[illegible]	45
466,234	778,117	1,297,354	372,861							46
										47
			46,112	267,530	1,189,656	2,425,197	2,372,774	2,407,514	1,457,003	48
114,146										49
29,199										50
	50,113	680,274	608,705	554,822	1,196,462	1,028,516	1,022,1[illegible]			51
	450	14,282	60,881	5,428	177	5,048	12,740	9,860	5,827	52
74,648										53
	550		3,148	2,528	10,792	7,[illegible]	6,001	1,147	6,499	54
884,116	845,167	867,457	515,526							55
				11,[illegible]	61,677	15,187	7,888	7,[illegible]	7,212	56
				821,880	1,147,472	957,[illegible]	870,814	131,[illegible]	72,012	57
52,150										58
	215,678	194,890	169,176	81,[illegible]	211,680	150,80[illegible]	21,748			59
13,721										60
							110,[illegible]	163,710	93,143	61
50,457			[illegible]	62,671	111,610	112,148	103,156	80,808	78,822	62
	58,145	59,199	60,761							63
7			55	689	65		424	65	1,[illegible]	64
2,508										65
56,888										66
5,567	77,482	65,808	64,42[illegible]	37,123	71,28[illegible]	71,869	52,111	51,[illegible]	8,074	67
3,029										68
1,229										69
1,758	19,066	12,681	8,182	24,88[illegible]	24,768	22,701	32,[illegible]	24,009	[illegible]	70
2,126										71
2,664										72
1,163	12,87[illegible]	9,759	10,078	9,403	15,151	12,660	11,739	11,972	12,512	73
87,961	57,763	88,515	88,487	41,620	62,292	18,289	17,458	32,900	15,[illegible]	74
7,658	1,580	1,066	1,948	608	128	1,831	91,865	40,780	86,088	75
	8,882	18,691	26,695	28,484	52,880	33,430	42,358	24,720	12,802	76

TABLE 75.—IMPORTS FOR

	MINERAL	1902	1901	1900	1899
77	Monazite sand or thorite	12			
78	Natural gas	35,964	100,989	131,065	119,430
79	Nickel ore and nickel matte	1,426,083	1,337,507	1,070,980	1,183,924
80	Nickel and nickel matte containing not more than 2 per cent of copper				
81	Nickel in ore, matte, or other crude form, not ready for consumption in the arts				
82	Petroleum, crude	175	17	1,400	82
83	Phosphates, crude	112,461	152,780	86,765	104,747
84	Platinum, unmanufactured	147,928	185,370	186,883	242,321
85	Platinum ore				
86	Plaster rock or gypsum, crude	250,928	213,317	242,643	192,180
87	Plaster rock or gypsum, ground or calcined	19,629	15,446	22,387	13,812
88	Plaster of Paris or gypsum; plaster of Paris and sulphate of lime, unground				
89	Plaster rock or gypsum, calcined				
90	Plaster rock or gypsum, ground				
91	Plumbago	903,350	930,102	2,346,587	1,081,871
92	Pumice stone, unmanufactured	19,863	28,618	27,562	29,580
93	Pumice and pumice stones				
94	Quicksilver	686	899	296	61
95	Rock crystal, manufactures of, not elsewhere specified	6,689	3,734	11,003	20
96	Rotten stone and tripoli	50,544	24,556	9,541	24,495
97	Silver ore and bullion[1]	23,990,977	[illegible]	[illegible]	25,129,142
	Stone:				
98	Ballast	12	12,090	2,197	690
99	Breccia in blocks or slabs	17	816		3,359
100	Curling stones or quoits and curling stone handles	1,116	2,535	1,453	1,020
101	Buhrstones in blocks, rough or unmanufactured	20,968	38,525	21,087	19,988
102	Buhrstones, manufactured or bound up into millstones	1,298	943	635	580
103	Buhrstones in blocks, rough or manufactured or bound up into millstones				
104	Cliff stone, unmanufactured	21,472	30,922	15,716	14,147
105	Flints and flint stones, unground	59,650	64,297	40,175	27,706
106	Flint, flints, and ground flint stones				
	Freestone, granite, sandstone, limestone, etc., except marble and onyx, not specially provided for—				
107	Hewn, dressed, or polished	38,611	22,189	111,227	107,248
108	Unmanufactured or undressed	17,619	12,628	16,641	19,270
109	Granite, unmanufactured or undressed	6,525	2,070		
110	Granite, hewn, dressed, or polished	57,792	100,512		
111	Grindstones, finished or unfinished	86,061	90,585	84,030	70,291
112	Lime	92,152	65,118	62,462	58,135
113	Limestone				
114	Lithographic stones not engraved	150,681	123,196	81,141	76,000
115	Marble and onyx, and manufactures of	1,264,860	891,067	778,478	688,135
116	Polishing stones				
117	Polishing and burnishing stones				
118	Slate roofing		3		
119	Slates, slate chimney pieces, mantels, slabs for tables, and all other manufactures of slate	1,817	6,467	6,928	4,025
120	All other manufactures of stone, not otherwise provided for		558	13	120
121	Sulphur ore, as pyrites or sulphuret of iron, natural, containing in excess of 25 per cent of sulphur	1,571,177	1,184,880	1,207,661	1,064,066
122	Sulphur or brimstone, crude, in bulk	3,582,930	2,870,115	2,702,282	2,362,681
123	Talc, ground, powdered, or prepared	35,907	354	760	1,362
124	Talc				
125	Tungsten and ferrochrome	12,644	11,594	14,374	37,798
126	Uranium, oxide and salts of	12,940	15,673	7,486	6,560
127	Wolfram ore				

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[1] Imports less foreign exports.

CONSUMPTION: 1889 TO 1902—Continued.

1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	
										77
90,294	84,812	91,007	79,087	66,528	92,199	69,082				78
956,039	537,128	612,755	355,717	397,816						79
					280,712	161,891	68,659			80
								11,687		81
				20			214		272	82
62,398	79,676	153,370	159,169	123,714	131,066	192,733	297,057	209,764	333,967	83
144,313	92,619	70,102	189,028					702,023	648,960	84
								5,250	16,367	85
171,745										86
21,303							26,191	19,395	29,972	87
23,269	157,926	222,189	182,315	171,915	216,779	211,225	176,588	180,357	185,236	88
2,080	18,069	23,425	11,666	10,718	25,276	22,554	7,185			89
100	119	97	2,669	8,196	11,618	66,861	58,038			90
472,401	321,355	384,504	206,935	410,819	866,309	726,648	509,719	573,561	248,926	91
16,821										92
3,075	66,037	59,894	47,995	43,768	51,795	52,063	52,411	55,411	57,082	93
9,978	10,223	46	7,014	6,278	38,100	67,870	254,587	228,628	98,806	94
1,292										95
9,886	11,852	6,324	6,033	8,988	15,006	13,041	8,119	7,896	6,660	96
23,163,255	23,750,369	20,126,314	13,915,181	2,728,515	15,674,689	14,838,584	15,051,325	14,802,697	12,318,587	97
	847	3,302	5,282	2,776	3,802	6,346	4,223	1,192	2,569	98
878	172				276	663	626	1,169		99
1,222	2,273	951	235	447	1,585	1,332	1,036	2,781	1,164	100
21,008					36,438	25,703	36,470	41,951	85,097	101
1,338			317	827	68	293	630	715	325	102
	23,570	28,862	18,018	20,414						103
18,884	26,685	33,312	10,724	17,212	16,687	20,860	16,010	16,997	26,195	104
11,186		16,732								105
	10,707		9,456	6,807	9,570	10,247	8,886	1,660	3,322	106
165,148	255,049	320,433	292,582	369,040	459,148	388,251	300,663	314,621	249,071	107
14,088	29,633	21,833	32,154	39,694	47,131	92,882	76,511	115,577	75,098	108
										109
										110
48,578	54,494	62,979	50,659	50,071	66,656	62,094	56,402	51,321	52,642	111
60,879	56,385	76,302	90,293	87,513	111,418	135,332	167,739	154,259	110,228	112
				6	160	51		712	962	113
51,730	68,505	96,676	95,342	55,295	128,776	100,339	106,652	89,573	93,612	114
626,716	993,209	932,720	861,930	711,290	1,178,403	910,832	822,210	763,706	572,613	115
					6,570	5,839	8,579	1,018	4,184	116
183		3,812	6,631	5,192						117
28	72	224								118
4,866	4,297	6,191	6,669	6,242	6,671	4,955	12,873	34,602	35,928	119
152	132	232	820	21	5,914	6,032	12,560	26,466	15,928	120
710,672	687,292	629,283	666,574	702,021	651,814	501,892	77,614			121
3,023,121	2,047,786	1,863,359	1,685,564	1,321,792	2,306,571	2,521,180	2,405,783	2,186,658	2,025,786	122
6,352										123
	32,658	28,276	12,557	8,455	9,597	3,285		32,558	6,213	124
71,271	17,260	14,111								125
5,244	3,158	5,021	2,428	3,251	2,879	3,626	1,974	2,257	1,607	126
896										127

CHAPTER III.

ELECTRICITY IN MINING.

By Thomas Commerford Martin.

The mining industry to-day constitutes one of the most important fields for the application of electric current. There is hardly a country in the world and hardly any department of mining in which electrical appliances are not employed, and in many instances the installation and equipment are of a most extensive character. Indeed, the subject has become so important as to create a literature and a technology of its own, for many of the problems involved are such as do not arise in connection with other work. Hence a brief technical review of the situation can not but prove of interest, especially as the whole tendency of the time is to develop mining industries along electrical lines, and in fact to employ electricity continuously from the very first contact with the ore to the stage at which the finished product is ready for the market. It is proposed, however, to limit the present treatment of the subject to electric mining, as both electro-metallurgy and electro-chemistry are distinct fields of technical work, dealing with manufactured material rather than with the cruder and more primitive processes of winning the minerals from the soil. In its early stages electric lighting was applied to mine work, and this development was followed by the use of electric locomotives for traction as a substitute for human or brute power. Of late years the electric motor has been utilized for all classes of work—drilling, coal cutting, hoisting, pumping, ventilating, etc. The use of electric explosives has long been familiar to every miner, and more recently the telephone has become a familiar adjunct for purposes of intercommunication.

In the United States, as elsewhere, the introduction of electrical mining apparatus has been greatly stimulated of late years by the high degree of perfection attained in the art of power transmission. A great many mines and mining camps in regions where fuel was either very costly or difficult to obtain have been brought within the range of profitable working through the utilization of some distant waterpower. The single and polyphase alternating current, with its flexibility and high range of pressure, has made it possible to transmit power from water courses across valleys and over mountain ranges for scores of miles, so that to-day large areas, which but for the assistance of electricity would have remained neglected, because unavailable, are being worked. The profitableness of American mines and the sources of national wealth have thus been enormously increased.

The practical use of electricity involves a great many questions, of the nature of which some idea may be formed from the report recently issued in England by a departmental committee appointed by the British Home Secretary to consider and report on the subject. As the result of its investigation the committee laid down four general principles which, it considered, should govern the appointment of electrically equipped mines. These points may be summed up as follows:

1. The electric plant should always be treated as a source of potential danger.
2. The plant should be of thoroughly good quality and so designed as to insure immunity from danger by shock or fire, and periodical tests should be made to ascertain that this state of efficiency is being maintained.
3. All the electrical apparatus should be under the charge of a competent person.
4. All electrical apparatus which might be used where there was a possibility of danger arising from the presence of mine gas should be inclosed so as to prevent such gas from being fired by the sparking of the apparatus, and when any machine is working every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed such machinery should be immediately stopped.

Some of these points seem obvious, yet they have frequently been disregarded. With regard to the first and second, the committee pointed out the fact that under the peculiar conditions existing in mines no absolutely safe limit of voltage or of pressure of current could be stated. The committee decided, however, on grounds already recognized in Germany that, provided all reasonable safeguards were adopted, a fairly high pressure had advantages, even from the point of view of safety, over a uniformly low pressure. The standard adopted by the board of trade as to voltage in consumption circuits is, therefore, 650 volts. Under certain conditions voltages as high as 3,000 volts are available for transmission purposes.

As to the working of electric coal cutting machinery in places subject to fire damp, the committee decided, largely as a result of experiments made, that it was necessary to inclose the entire motor in a flame-tight cover. The committee adopted the view that all permitted explosives should be fired by electricity, and that the armored sheath or covering of all protected cable should be connected to "earth"—i. e., grounded.

Table 1 shows the number of mines in the United States reported as owning or renting electric power in 1902, together with the horsepower reported, for each group of minerals.

TABLE 1.—*Electric power, by minerals: 1902.*

MINERAL.	TOTAL.		OWNED.		RENTED.	
	Number of mines reporting.	Horsepower.	Number of mines reporting.	Horsepower.	Number of mines reporting.	Horsepower.
All minerals	802	154,050	688	130,494	131	23,556
Asphaltum and bituminous rock	1	25	1	25		
Bauxite	2	64	2	64		
Borax	1	1	1	1		
Cement	31	20,862	26	17,420	5	3,442
Coal, anthracite	17	5,755	17	5,755		
Coal, bituminous	309	68,139	301	65,972	18	2,167
Copper ore	35	4,648	22	2,312	13	2,336
Fluorspar	1	25	1	25		
Gold and silver	292	46,472	224	32,003	71	14,469
Graphite	1	10			1	10
Gypsum	3	68	3	68		
Infusorial earth, tripoli, and pumice	1	5	1	5		
Iron ore	9	937	9	937		
Lead and zinc ore	13	1,482	13	1,475	1	7
Limestones and dolomites	21	871	19	769	3	102
Marble	7	2,220	7	2,220		
Mica	1	16	1	16		
Natural gas	4	275	4	50	1	225
Petroleum	7	150	4	25	3	125
Phosphate rock	3	500	3	500		
Quicksilver	1	15	1	15		
Sandstones and quartzite	5	67	5	60	1	7
Siliceous crystalline rocks	27	913	18	442	9	471
Slate	7	225	2	30	5	195
Sulphur and pyrite	2	80	2	80		
Talc and soapstone	1	225	1	225		

It will be seen from this table that the number of mines reporting electric power was 802, with a total of 154,050 horsepower. By far the larger proportion of these—namely, 688, with a total of 130,494 horsepower—operated their own plants. There were 131 mines, with a total of 23,556 horsepower, which rented power, but of these mines 17 owned power also. It will be gathered from these figures that the 130,494 horsepower, even if it represents the total current-generating capacity, shows a considerable application of electric power; but it should probably be doubled in order to ascertain the capacity of motors installed and using such current. It is a fact well known in electrical plants that motor capacity far beyond the actual current capacity of the generating plant can be installed, for the reason that the consumption of current is variable and intermittent, it being highly improbable that all the consuming apparatus will take full current from the lines at the same time. It is assumable, however, although the fact is not brought out at all in the table, that in a great many instances these plants furnish also considerable current for lighting purposes. With regard to the rented power, it is probable that it is employed almost altogether to drive motors, a very small proportion of it representing electric lighting. Mines in which the operations are so small as not to necessitate the installation of a separate plant are, it is assumed, operated largely by single shifts or during daylight hours; so that while some lighting would be needed, the consumption of current would be quite small in proportion to the consumption for hoists, pumps, and other motor-driven mechanism.

It will be noted that four-fifths of the electric power reported was concentrated in three industries—coal mining, cement working, and the gold and silver industry. By far the largest item is that of bituminous coal mining, such mines, numbering 309, reporting electric power with a total of 68,139 horsepower; and these figures must be supplemented by those for anthracite coal mining, with 17 plants, reporting 5,755 horsepower. It will be seen that those two groups alone represent nearly one-half of the total horsepower. The figures for gold and silver are combined, and the table shows 292 plants reporting, with a total of 46,472 horsepower. The other category is that of cement mining. There were 31 cement mines reporting electric power, with a total of 20,862 horsepower.

It will be observed that these various mines differ considerably as to the magnitude of installation. In the gold and silver mines the plants have an average capacity of about 160 horsepower; in the coal mines the average capacity is 227 horsepower; in the cement mine works the average capacity is greater than for any other kind of mines—about 675 horsepower. The other items in the table, while interesting, do not call for any particular comment.

Power generation and transmission.—Electric current for mining purposes is usually obtained in one of two ways, depending somewhat upon the nature of the mine in the first place, and secondly upon the environment. In coal mining regions it is natural that each mine should draw upon its own fuel resources for power, the plant being stationed at the pit mouth; but even in such cases, where there is a group of mines it is sometimes found convenient to concentrate the power-generating apparatus, transmitting the current to a distance. This has been done in an even more comprehensive way in western mining fields, one steam plant which utilizes coal delivering its energy to mines no less than 26 miles distant, in districts where waterpower is not available. Where the generating plant is at the mouth of the mine it is customary to employ apparatus producing low tension direct current; but where longer distances are involved the alternating current has been resorted to, in the same manner as in central electric lighting and railway plants. The current is generated at high potential by polyphase dynamos and transmitted to substa-

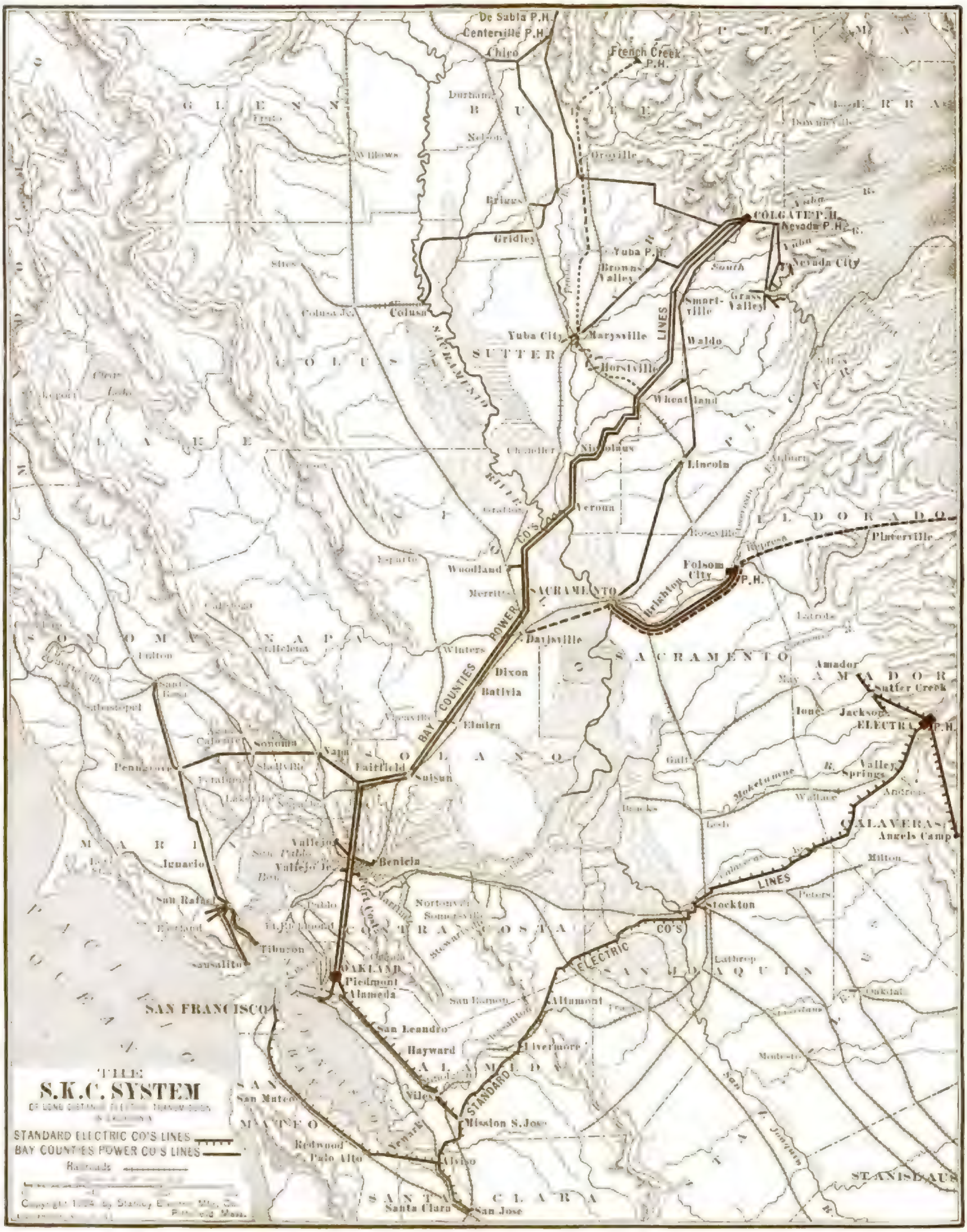

PLATE I.—LONG DISTANCE ELECTRIC TRANSMISSION IN CALIFORNIA.

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tions, where it is lowered in pressure and converted into direct current for use.

One of the first plants of this kind for a mine haulage system was installed at Ehrenfeld, Pa. The haulage in this mine was accomplished by rope driving and mules until the main heading, which should eventually extend 5 miles underground, was nearly 2 miles long. This method was then replaced by an electric system embodying the generation of a 3-phase, 25-cycle, 5,600-volt alternating current near the pit mouth. This current is transmitted by insulated cables to a substation in the mine itself, near the center of the actual operations and about 9,000 feet from the power house. Through the intervention of static transformers and a rotary converter, direct current at 275 volts is then delivered to the haulage circuits.

In the Tug River field, near Welch, W. Va., is another plant of the same kind by which three mines are operated, alternating current induction motors being employed for driving coal crushers and conveyors and direct current for the other mine operations.

An interesting variation of this plan is that embodied in the plant constructed for the Raton Coal and Coke Company, at Blossburg, N. Mex. When built, in 1897, the coke plant included some seventy-five 3-foot ovens, in double banks. In the center was erected a large battery of boilers, to which the waste gases from the coal are conducted through central flues; the gas thus made available is employed to drive gas engines and dynamos furnishing power for the hauling plant both inside and outside of the mine. About a mile and a half from the coke ovens is situated the washing and crushing plant, with a capacity of 800 tons in ten hours. All the machinery from tipple to mine opening is driven by electric motors, a trolley line with electric locomotives bringing the pit cars from the main entry to the tipple. This idea of the utilization of waste gas in coke fields and blast furnaces has of late occupied considerable thought and attention on the part of mechanical and mining engineers, and important developments are resulting from the employment of electricity as a means of lessening waste.

In most mining districts, however, the work is intermittent, machinery is widely scattered in places difficult of access, fuel is expensive, and the economical use of steam is not possible. Compressed air, as a means of transmitting power, is handicapped by loss in the compressor and the piping, and is limited to short distances and to the operation of apparatus requiring power regardless of cost. In this connection, reference may be made to the tests reported by Mr. Lewis Searing, in 1896, with electricity and compressed air, in a mine situated at Rouse, Colo., at an altitude of 6,000 feet. The actual results obtained with the two plants show that the work of pumping, which in the case of compressed air required 312 horsepower and 8 boilers, could be done by electricity with but 56 horsepower and 1 boiler. This, of course, is an extreme case, but it indicates the difficulties attendant upon the use of compressed air at such altitudes.

Under the modern conditions of power transmission from waterfalls, etc., electricity has shown itself to be largely independent of distances, so that, as was pointed out by Mr. F. O. Blackwell, before the American Institute of Mining Engineers, in February, 1903, a given amount of power can be delivered either 528 feet away, at 100 volts, or 50 miles away at 50,000 volts, with the same total amount of copper per horsepower and exactly the same loss of power in the transmission circuit. With proper choice of potential and system, this loss need not exceed 10 per cent, even when the current is carried as far as 150 miles.

So much has been done in the matter of power transmission for mining purposes that it is difficult to pick out any specific case as thoroughly typical. But it would be hard to find an instance more notable than that of the Standard and Bay Counties Power Companies, in California. These, consolidating other systems, have a remarkable network of circuits of which one of the largest begins at Colgate, in the foothills of the Sierras, on the North Yuba river, a second at Folsom City, a third at Electra, and a fourth at De Sabla. From Colgate to Oakland, where the Bay Counties Company's line ends, is a distance of 152 miles; from Oakland to San Francisco, by the Standard Company's line, is 70 miles. The tying in at Oakland thus gives a transmission circuit of 232 miles from the latest plant at De Sabla, beyond Colgate, around San Francisco bay and through San Jose to San Francisco. Over the network thus represented, which embraces no fewer than 16 counties, within whose borders lie one-half of the population and three-fourths of the total assessed valuation of property of the state, several thousand horsepower is delivered daily. Alternating current is distributed to substations at pressures of 40,000 to 60,000 volts, and there manipulated and rectified for delivery to establishments engaged in a variety of industries, including a large number of mining plants.

The Bay Counties system is in fact an outcome of earlier mining enterprises, one of which was undertaken for Nevada county to supply the mines there with power. In like manner the Standard system is an outgrowth of work started thirty years ago by the Blue Lakes Water Company, when a ditch system considerably more than 80 miles in length was constructed for the purpose of furnishing water to the mines in Amador county. For a long period this company was very prosperous, but with the decline of mining in that section of the mother lode and the complete abandonment of hydraulic mining the property became much less profitable. At this stage it was taken up again by Prince Poniatowski, to be developed for the purpose of distributing electric power to mines and thus lessening the cost of their operation.

The plant at Colgate had an initial equipment of 15,000 horsepower in 3-phase alternating-current dynamos, situated in a power house at the foot of a hill 1,500 feet high. Water for driving the turbines is brought to this plant through a timber flume over 7 miles long draining 500 miles of watershed, and with a capacity of 33,000 cubic feet of water per minute. This water, received in the reservoir near the crest of the hill, falls with 700-foot head upon the turbines under a pressure of 304 pounds per square inch. The current from the generators is delivered at a pressure of 2,400 volts to step-up transformers, which put it on the circuit at a pressure of 40,000 to 60,000 volts. These transmission circuits, each of three wires, are carried on lofty poles of Oregon cedar and are in duplicate, one set consisting of hard-drawn copper wire and the other of aluminum. At the Karquines straits the circuit crosses in one span of 4,448 feet of sagging steel cable 200 feet above tide water and held up by enormous steel lattice towers. The system has in operation about 700 miles of line at 50,000 volts, 70 miles at 40,000, and a great many miles at 23,000, 16,000, 10,000, and 5,000 volts. It is stated with regard to the efficiency of the transmission that 1,000 horsepower at the Colgate water wheels nets roughly about 750 available horsepower in San Francisco, 222 miles away, the loss being 6 per cent in the generators, 2 per cent in the step-up transformers, 2 per cent in the step-down transformers, and 15 per cent in line losses, etc. This does not represent the general efficiency of the whole system, because there are a great many branches and tap circuits, to mines, etc., but it is understood that the results attained by the system as a whole are such as to have stimulated the construction of similar plants, one of which has been erected for mining purposes, with American apparatus, at the Cauvery Falls, Madras, India. Such a plant as this is a sufficient exemplification of the possibilities involved in electrical power transmission for mining purposes, utilizing the energy of falling water.

Such transmission will again be referred to incidentally in connection with certain utilizations, but before closing this section reference should be made to the important work undertaken for electric power distribution from coal mines in England and Wales, a country with cheap coal but very little available waterpower. Since 1901 there have been established a number of plants and companies for long distance transmission, based upon coal mining and intended largely for mining purposes. In fact, one of these, at Newcastle-upon-Tyne, covering a strip of territory in the vicinity of the Tyne river, began on a small scale in 1898; it was greatly enlarged in 1902. One in southern Wales covers the coal and iron field of that section. One in Lancashire covers the coal field of that county, extending on the west to the Irish sea. One in the county of Durham covers 250 square miles of coal territory, extending to the North sea. One in adjacent territory, including the Cleveland iron field in Yorkshire, covers an area of 820 square miles, while one in southern Yorkshire covers 1,800 square miles. One in the counties of Leicestershire and Warwickshire covers 1,699 square miles, while one in the county of Cornwall, particularly designed to revive the decaying mining industries of that famous old tin region, covers 1,356 square miles. Another system in Derbyshire and Nottinghamshire deals with an area of 1,500 square miles.

A few details may be given as illustrative of the extensiveness of the English enterprises, some of which are now actually in operation. Within the area of Derbyshire and Nottinghamshire—containing some of the largest coal fields in the world—are electric power companies with a capital of about $9,000,000. There are within it 564 individual works of importance, of which 159 are coal pits, and no fewer than 400 firms, representing a capital of about $100,000,000, supported the enabling bill when passing through Parliament. It was proposed at first to have for this area four large generating stations, with a total capacity of 60,000 horsepower, but in 1903 the applications for power so far exceeded the estimates that it was even then proposed to enlarge at least two of the generating stations. While in the individual mines and mining enterprises the largest individual dynamo or engine unit is 200 horsepower, the smallest unit for this system is one of 3,000 horsepower. The numerous collieries in the region are counted upon as the principal customers for this supply of current, and, taking as a basis the fact that about 7 per cent of the coal mined is consumed in obtaining the 93 per cent sold, it is estimated that by the use of electricity in mines under these new conditions, in connection with the various purposes of hoisting, traction, pumping, ventilating, etc., 10,000,000 tons of coal can be saved annually. The operations of the power companies at Newcastle-upon-Tyne have shown that power can be delivered to large works in the vicinity at a rate slightly exceeding 2 cents per kilowatt-hour unit—that is, at a rate of about 1½ cents per horsepower per hour. Elsewhere in England and Wales the collieries themselves have demonstrated the efficiency of electric power transmission, as, for example, in the case of the Tredegar Iron and Coal Company, in Monmouthshire, Wales, whose plant is the largest of the kind for individual mining enterprise in England or Wales. Two 300-horsepower engines direct connected to 3-phase generators at one set of mines supply current over pole line transmission circuits at 2,000 volts to other mines about a mile and a quarter away. Both electric haulage and electric pumping are features of this installation, and at the time of the last report it was noted that, although these mines were peculiarly subject to fire damp, no accident of any kind had happened because of the special precautions taken to insure safety.

One installation which will serve to exemplify the latest general features of current transmission, as well as economical generation at the mine, is furnished by the central power plant of 2,000 horsepower installed by the coal mining department of the Delaware, Lackawanna and Western Railroad Company in Scranton, Pa., to supply current for drills, locomotives, hoists, pumps, lights, etc., in the Diamond, Hampton, Brisbin, Hyde Park, and Sloan mines. The alternating current is transmitted at a pressure of 2,300 volts, and reduced at substations at the various mines by step-down transformers and rotary converters to direct current, which is employed in the mines, supplemented by two alternating induction motors of 800 horsepower each in a water-hoisting shaft 600 feet from the power plant. The greatest distance to which power is transmitted is about 15,000 feet, to the Diamond mine, which takes about 175 horsepower. The current is furnished to some 14 electric locomotives in the various mines, ranging from 6½ to 13 tons, and to a 120-horsepower electric hoist. Added to the previous plant of the company the generating apparatus represents a capacity of about 5,000 horsepower, supplying current to 45 electric locomotives, 14 motor-driven pumps, 18 operative hoists, 14 motors in a breaker, and 1 electric drill, or a total of 6,820 horsepower in consumption capacity. It has been decided to increase the plant so as to transmit current 3 miles, to supply power for operating 25 direct-current motors at the Delaware, Lackawanna and Western locomotive repair shops, etc., 100 arc lamps for lighting freight yards, machine shops, etc., and 1,500 incandescent lights for a passenger station, freight office, and roundhouse. The most notable thing about this new plant is the fact that the additions to which special reference has been made employ the latest form of steam equipment in the shape of steam turbines instead of the more familiar reciprocating steam engine. These turbines, two of which were already installed at the time of the compilation of these notes, are each of 500 kilowatts, or about 675 horsepower capacity, and will carry 50 per cent overload for two hours, or 100 per cent overload momentarily, without injurious heating of the generator.

Coal cutting machinery.—Electric coal cutters constitute one of the largest classes of mining machinery employing electric current. The considerable increase during recent years in the proportion of machine mining as compared with that of pick mining is doubtless due to the adoption of these machines. According to the report of Mr. E. W. Parker on the production of coal, published by the United States Geological Survey, the number of coal mining machines in use in this country in 1898 was 2,622, but in 1902 it had increased to 5,418; all of these were employed in bituminous coal mines.[1] The increase during recent years is attested to also by the fact that while in 1891 the mining machines of the country produced slightly less than 7 per cent of the total product of bituminous coal, in 1902 they produced somewhat over 26 per cent.

The older form of machine is of the pick or puncher type run by compressed air, but of late years the chain form driven by electricity has rapidly come into use. Of the 5,418 machines in use in 1902, 58.8 per cent were of the compressed air or pick type, while the other 41.2 per cent were electric or chain machines. Of the 2,238 chain machines, almost all were of breast form, only 51 being of the long-wall style.

Some interesting details with regard to the introduction and utilization of electric coal cutting machinery were recently made public by Mr. S. B. Belden, who is connected with one of the largest concerns manufacturing such apparatus. Speaking of the first chain machines, designed by Mr. J. H. Jeffrey, Mr. Belden stated that their height precluded the possibility of operating them in thin coal, and that for several years no attempt was made to build a machine designed specially for such work. Even when the chain machine was an established success, it was a question whether a machine weighing more than a ton could be employed in coal ranging between 32 and 36 inches in thickness. But after these large machines had proved successful in thick veins they began to be used in lower coal until the minimum thickness of the vein had been reached.

Gradual evolution has produced a smaller and lighter machine, so that there is now in use one which has a height of only 18 inches, or, with the moving truck, of 28 inches, and a weight of only about 2,500 pounds. As this machine rests upon a wide flat shoe board it can easily be moved along the face of the coal by the operator and his helper. A brief description of the apparatus will be of interest. On an outside frame, consisting of two steel channel bars and two angle irons riveted to steel crossties, rests a sliding frame consisting of a heavy channel or center rail, to which is bolted the cutter head. The cutter head is made entirely of two milled steel plates, which bolt together, forming the front guide for the cutter chain. This chain, which is made of solid cast steel links connected by drop-forge straps, is carried around idlers or sprockets placed at each end of the cutter head and along the chain guides at the side to the rear of the machine, where it engages with and receives its power from a third sprocket, under the motor. The electric motor, which is of ironclad multipolar type, rests upon a steel carriage, which forms the bearing for the main shaft. The thin vein machine is equipped with a self-propelling truck, the motor which operates the machine being also geared to the truck axles. A reversing switch is provided, so that the truck can travel in either direction, and when the machine has reached its stopping point, either forward or backward, it is checked by an automatic cut-off. The return travel is made in about one-fourth of the time required to make the cut.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 325 to 327.

Where the grades are heavy the truck is of advantage, and where the room lies to the dip it obviates the necessity of brushing down the roof for the entry of mules.

It is stated by Mr. Belden that many mines having only 28 to 30 inches of coal are being operated entirely with thin vein machines, and that a fair average for such machines is the cutting of at least 50 tons of coal per eight-hour shift. As nearly all of these machines are operated by two shifts, the output of a machine working in such a vein can be reckoned at 100 tons per day. Many small mines have a daily output of only 400 tons, and it is estimated that $10,000 will cover the necessary expenditure for an electric equipment of about 100 horsepower, affording sufficient power to keep four such machines in simultaneous operation, besides furnishing power for lights, pumping, ventilation, etc.

According to the schedule adopted in No. 8 vein of Ohio coal, the cost of pick mining in rooms is 90 cents per ton, while the cost of machine mining in rooms is 11 cents, with 52½ cents for loading after machines in rooms. This shows a saving through the substitution of machine mining for pick mining of 26½ cents per ton. A liberal allowance for operation and depreciation would leave a net saving of over 13 cents per ton, and the four machines should produce at least 75,000 tons per year. Numerous data received from various mining sections bearing upon the cost of operating such apparatus per ton of coal give figures ranging from one-tenth of 1 cent up to 2 cents, according to the hardness of the coal and the degree of care and skill observed in operating.

Discussing the subject in an admirable article on coal-cutting machinery, Mr. E. W. Parker expressed the opinion that the evolution of the chain machine was one of the most notable steps—and practically the final step—in the development of a successful mining machine. The speed with which the chain machine can do its work seems incredible. After the machine has been placed in position an average period of only five minutes is required to make a cut 44 inches wide, 4½ or 5 inches high, and 6 feet deep, and then withdraw the cutting frame. In fact, for one of these machines there is claimed a record of cutting 1,700 square feet in nine and one-half hours. This would mean that about seven and one-half minutes were required for each cut 44 inches wide and 6 feet deep, including the moving and setting of the machine. An average much lower than this would attest the efficiency and utility of the apparatus.

As to the advantages of the modern chain machine over the earlier forms of pick machine, the former bases its claims upon the rapidity with which the work is done, the very small amount of slack coal that is made in the cutting process, and the fact that the runner is not subjected to the wearisome racking of the pick machine. The advantages of the pick machine, which is driven by compressed air, and strikes about 190 to 210 blows per minute, are, first, that it can be used in mines where the narrow conditions of room and floor do not permit the introduction of chain breast machines; and, second, that in mines where the quantity of gas is so great that safety lamps have to be employed it obviates the dangers which might arise from sparking if a motor-driven machine were employed.

As already noted, several long-wall machines—driven sometimes by compressed air, but frequently by electric motors—are in use. As the name indicates, in long-wall mining the coal is extracted from a long face, which is gradually moved forward in widening, irregular circles. The nature of long-wall work is such that the face must be jagged or circular instead of straight and regular, as in room-and-pillar mining. One of the leading types of long-wall machines, involving to a certain extent the principle of the chain breast machine, consists of an endless chain operated along a narrow frame or arm extending from the side of the machine and so adjusted that it can be operated at any angle up to a right angle. A change in the angle of the cutting frame will increase or diminish the thrust on the track; in the same way the machine can be made to follow any irregularity of the face of the coal. The cutting frame can be extended over the right or left side, so that as the machine moves the cutting can be accomplished in both directions along the coal face. The height of the machine is only 18 inches, and its weight is only about 3,000 pounds, so that it can be operated in very thin veins. It has a wide range of cutting speed, and can be made to undercut to any practical depth. In going through narrow places and also in moving or changing the cutting bits, the cutting frame can be swung out behind the machine instead of from the side. Like the ordinary chain machine it is operated by two men, and is said to be as available for room-and-pillar work as for long-wall mining.

Shearing machines constitute another class of apparatus of this nature. They are built on the general plan of the chain undercutting machine. The cutter frame is located in a position normal to that of the undercutting, the shaft in the armature of the motor being parallel to the center rail. The best way of shearing a room or entry with such machinery is to make the first cut at the top of the vein, and then let the machine down far enough to make another cut. To provide for the secure and rigid support of the machinery the frame is clamped tightly to two columns, at points in line with the balancing position, and the front end is steadied by two auxiliary columns; the four columns vary in length according to the thickness of the vein worked. The capacity of the machine for cutting depends upon local conditions. With a standard type of this machine a single cut is 36 inches high, about 4 inches wide, and from 5 to 7 feet deep. From 50 to 100 feet of entry can be cut in a day of ten hours. Current for moving the machinery from one working

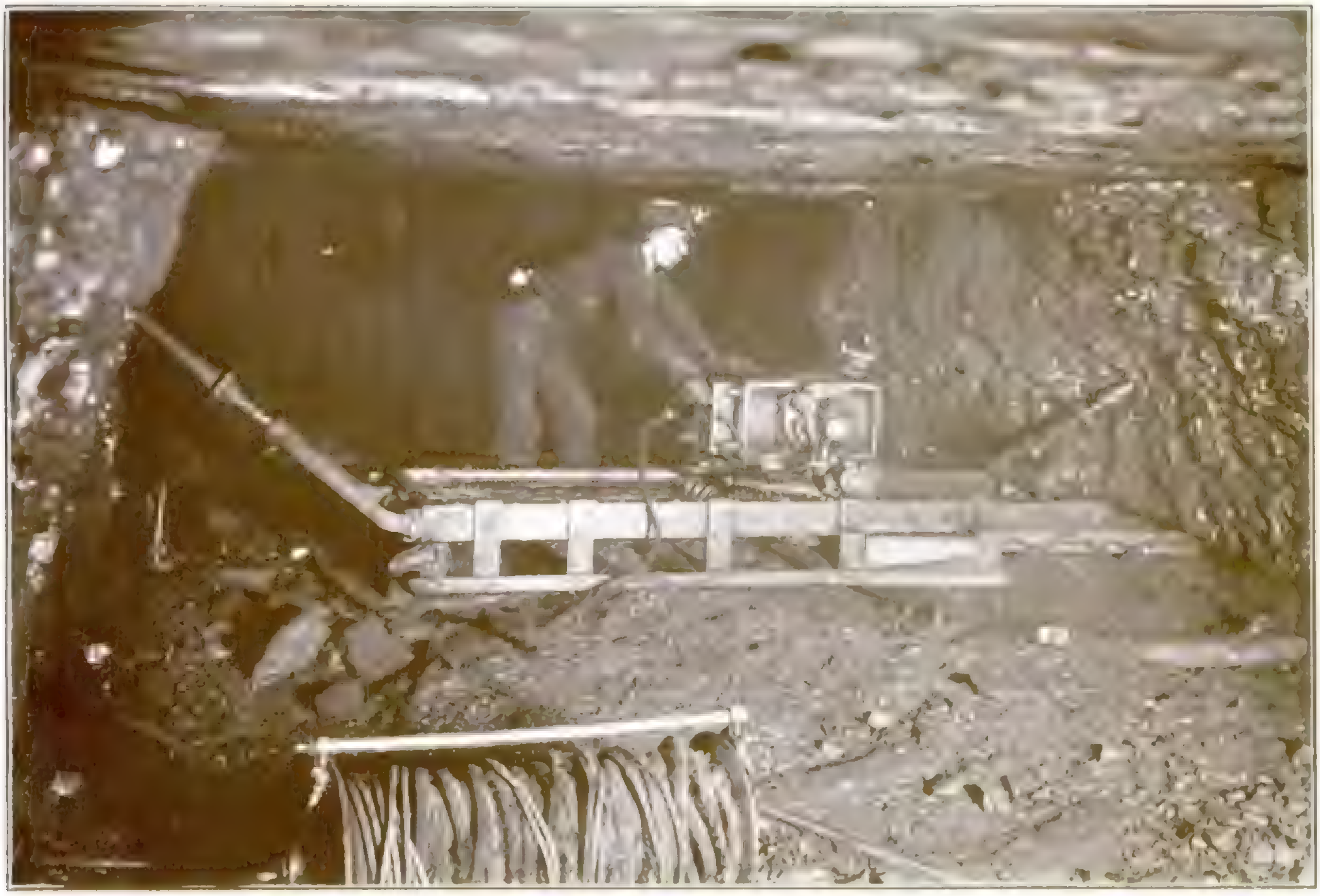

PLATE II.—ELECTRIC COAL CUTTER.

PLATE III.—ELECTRIC COAL CUTTER.

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place to another can be taken from trolley wires, and the machine can be run up to the face of the entry, which can be sheared without removing the machine from its truck wheels.

Drills.—The application of electric drills to mining work has been the subject of considerable study and experimentation for many years past, but not until recently have these drills been successful. Drilling is one of the few classes of operation in which a reciprocating motion is preferable if not necessary. The air drill has a reciprocating motion; the electric drill, on the other hand, necessarily has a rotary motion, the effort to develop electric power practically by reciprocating motion having been abandoned at a very early stage in the development of the electric motor. Moreover, the air drill has shown itself very hardy and capable of withstanding unlimited rough usage; whereas the electric drill has usually proved to be a delicate and sensitive piece of mechanism, easily deranged and expensive to repair. On the other hand, the degree of efficiency of the air drill is relatively low, the electric motor being able apparently to do the same work with a consumption of about one-tenth of the power. Moreover, the electric drill does not sustain the further loss in efficiency to which an air compressing plant is subject at a high altitude, nor is it affected by a low temperature, which in an air compressing plant freezes up the exhaust.

A report has recently been made in some detail with regard to results obtained with electric rotary drills as compared with air drills in some potash mines in central Europe. For the electrical equipment current is distributed through the mine by armored cables fastened to the roof. The motor is furnished with a reversing arrangement, such that two wires of the cable can be interchanged; by this means the rotating field of the motor, and therefore the direction of rotation of the motor, is reversed. The motor has a starting resistance; it develops normally about 1 horsepower, but can be overloaded with 1.5 horsepower for a certain length of time. The connection between drill and motor is made by a flexible shaft. The weight of the drill proper, which is fastened between two screw columns, is 99 pounds. The feed has been varied from 4 to 20 inches in one minute.

From a comparison of the weights and initial costs of electric and of air drill outfits presented in the report referred to it appears that the former is considerably heavier and more expensive. The annual cost of maintenance, however, amounts to from $16.63 to $19 for the electric drill, and to $29.69 for the air drill. Moreover, in spite of its greater weight, the electric drill can be erected and dismounted just as quickly as the air drill, principally because of the easier adjustment of the screw columns. To support the air drill these have to be screwed up with considerable force and strengthened, while for the electric drill, which works quietly and without jarring, they do not have to be fixed so rigidly. The adjustment of the electric drill itself is easier than that of the air drill, and when the screw column is moved the electric drill is left fastened to it. Tables of practical tests are given, recording the depth of hole, net time of drilling, drill pauses, total time of drilling, total and net time for 1 meter, and the number of replaced drills. From these tables it appears that the electric system affords a considerable saving of power and time. The efficiency of both kinds of apparatus is calculated in detail from the generating station to the drill; it is stated that the total efficiency of the electric drill is 0.29, while that of the air drill is 0.0223, or about as 1 to 13.

In coal mining operations the use of electric rotary drills and augers is quite common, and appears to be thoroughly successful from the fact that the rotary motion of the motor armature can be fully availed of. These drills are used for boring holes into the coal for shooting it down after it has been undercut. Many admirable types of these drills are illustrated in the catalogues of the manufacturers and are in wide use. They are so arranged that they can be operated at almost any angle, vertically or horizontally. They are generally mounted on light upright stands, with screws at the ends for fastening to the roof and floor, but some of the larger drills are mounted on trucks, so that they can be transported readily from place to place. The motors, which often are very small and light, not much heavier than a good sized fan motor, are mounted with an adjustable clamp, and are geared for either single reduction or double reduction, for reducing the high speed of the armature to that which is suitable for the auger. The larger rotary drills of this class have been equipped with motors of from 4 to 6 horsepower, the power being transmitted from the motor to the drill by means of a telescopic shaft and machine-cut bevel gears. The telescopic shaft consists of a steel tube in which slide two solid shafts, each of which is fitted with a universal joint, and is fastened to the motor and to the drill machine by means of an automatic coupling.

A number of electric percussion drills, striking a percussive or hammer blow, are in use. They are of various sizes. In some of them the power is transmitted from the motor to the drill by a flexible shaft, which may be several feet in length. In one form, equipped with a self-contained motor, the hammer proper is operated by a pair of eccentrics on a shaft connected through simple gearing to the armature of the motor. The raising of the hammer is effected during a three-quarter revolution of the eccentric shaft, and the blow is struck during the remaining quarter. A very powerful hammer blow is thus secured, at the rate of about 400 to 500 blows per minute.

Shot firing.—The electric method of shot firing in mines has reached considerable development of late years, and is now in general use. As a result of its investigations, the British departmental committee, already referred to, decided in favor of requiring electric shot firing in all pits to which the orders as to explosives in coal mines apply, and it is understood that in the majority of such pits this method has already been adopted. The order regulating the use of permitted explosives lays down the rule that the firing must be done with an efficient electrical apparatus, or by other means equally secured against the ignition of inflammable gas or coal dust.

There are two methods of electric blasting or shot firing—known as the high-tension and the low-tension—in ordinary use at the present time. In the high-tension method the explosion is caused by a spark which is made to jump between two points inside the detonator. The current for this spark is created by what is known as a magneto machine—an armature revolving rapidly in front of a set of permanent magnets, the whole mechanism being inclosed in a small box from which the handle attached to the armature extends. This box is portable and can be set down anywhere, and the wires from it can be carried a considerable distance. In the low-tension method there are employed similar magnetos of low tension, or chemical batteries. In this method the two wires which extend into the charge are connected, or bridged, at their ends within the priming with a short piece of fine platinum or similar wire. This wire offers considerable resistance to the passage of even a small current, so that it rapidly becomes heated to incandescence and thus ignites the priming, which in turn explodes the detonator charge.

The high-tension system is in very common use and can be seen in operation in almost any city where building foundations are being excavated in hard material. The low-tension system is quite popular in mines, however, the principal reason being, apparently, that the fuses are less subject to deterioration and can be stored more safely than high-tension fuses. They differ from the high-tension, spark-jump fuse also in that they can be tested by means of a battery and galvanometer in order to see if they are alive. The shots are fired either in series or in parallel; if the former, the current needs considerably higher tension in order to pass successfully through all the charges, but if in parallel a much lower tension is available, so that a battery of cells can be used.

The British departmental committee already mentioned pointed out two dangers to be apprehended from electric firing: First, the ignition of fire damp from a spark in the magneto machine or between the bare wires when in close proximity; and, second, the premature firing of the shot. To guard against the first danger, high-tension magnetos are inclosed—as has already been stated—in a flame-tight case and the fuses or detonating wires are connected up in such a way that there is no possibility of a spark passing from one wire to the other. Premature firing would appear to be the principal cause of almost all accidents, but in most instances carelessness is a contributory cause. It is difficult to see how the shot can be fired prematurely if the firing cable is first connected to the fuse wires and not attached to the firing apparatus until the shot firer is ready.

The British committee recommends that as an additional precaution the responsibilities be limited and the degree of safety increased by providing all magneto machines and cell batteries with removable handles, keys, or safety plugs, which should always remain in the custody of the shot firer. With regard to the use of batteries, it is urged that unless deterioration is carefully looked after they are of doubtful advantage for shot firing, because while their original cost is but a fraction of that of the magneto the cost of maintenance and of efficient working is much greater.

Mining traction.—The electric locomotive is one of the most striking examples of the application of electricity to mining, and its general use may be inferred from the report of the bureau of mines of Pennsylvania for 1902, which stated that there were 378 electric mining locomotives in use in the bituminous and anthracite regions of that state. Another fact bearing upon this subject is the statement in the Illinois coal report for 1901 that in 12 mines in that state over 2,000,000 tons of coal had been hauled by electricity during that year. These figures deal with haulage within mines, but it should be remembered that in many of the mining regions trolley roads are in use for handling ore, etc., which would correspond to freight roads, and for which no particular type of locomotive is necessary. It is believed that of locomotives built especially for such work about 3,000 are now in use in mines in the United States.

The first specifically electric mine locomotive employed in the United States was built nearly twenty years ago by Mr. W. M. Schlessinger for the Lykens Valley colliery of the Pennsylvania Railroad, and at last reports this machine was still in service. It weighed about 5 tons and was equipped with 32-horsepower electric motors, from which motion was imparted to the driving wheels by a chain and cog or sprocket connection. The conductor for supplying current to the locomotive consisted of a light T-rail carried on supports parallel to the track at a vertical height of about 5 feet and removed horizontally from the track rail about 20 inches. Current was conducted from this rail by means of three wheels pressed against it by a trolley arm, and the track rails were used as the return circuit. The ordinary train for this locomotive, which operated with a current of 450 volts and from 40 to 200 amperes, was 15 cars, each of which weighed 1 ton when empty and carried 2.35 tons of coal or 3 tons of rock. There were two haulage lines, one 9,500 feet long, in a drift, and one 10,400 feet long, in a tunnel.

Another early electric mine locomotive still in use is of 40-horsepower capacity and uses current at a pres-

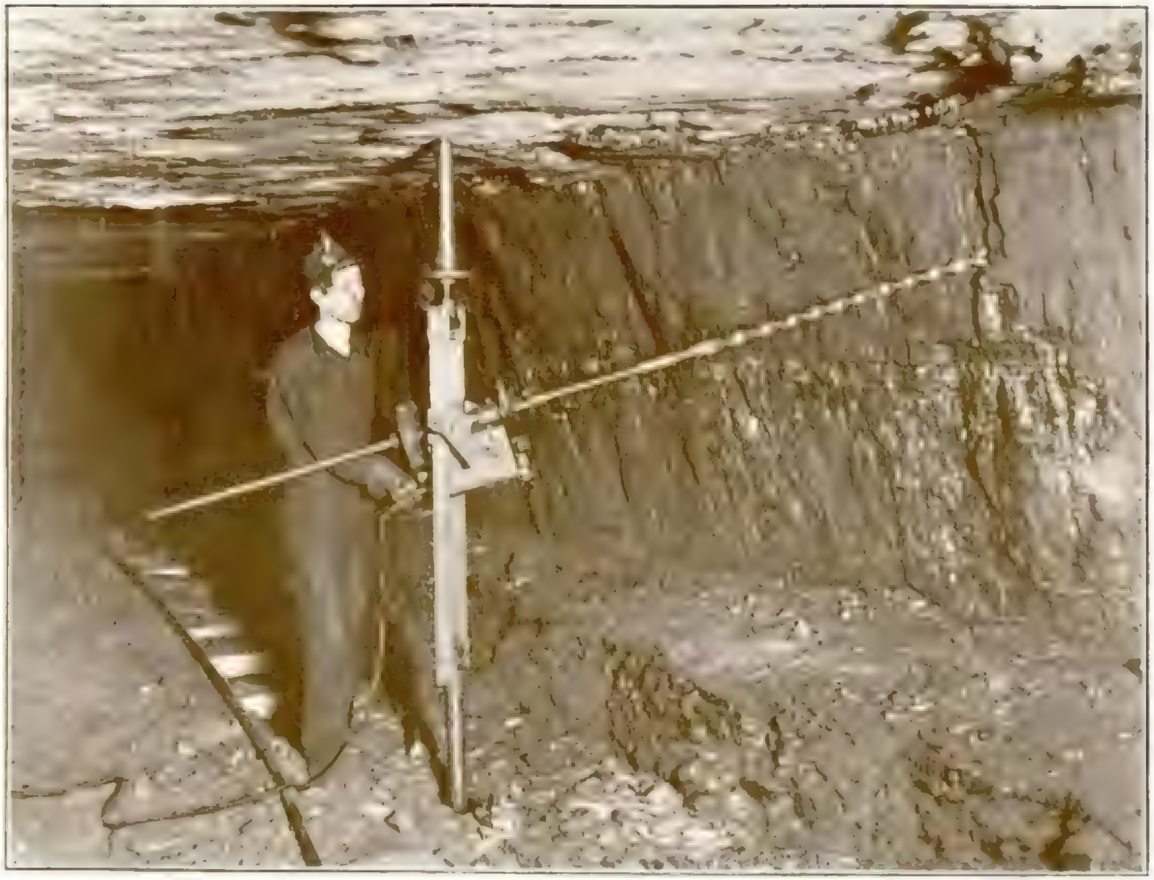

PLATE IV.—ELECTRIC DRILL AT WORK IN A MINE.

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sure of 220 volts, with a wheel gauge of only 36 inches. This machine is 5 feet 6 inches in height and weighs 10,500 pounds, with 1,800 pounds added to increase traction.

Some of the earliest work was done in Ohio, and after fifteen years of continuous service two of the first electric locomotives ever seen in a bituminous coal mine are still in use, hauling the output of a mine operated by the Upson Coal Mining Company, of Shawnee. It is interesting to note that this type of locomotive approximated street car practice, having a single motor with a double-reduction gear.

These locomotives, however, are examples of earlier practice in mounting the motors above the truck and gearing downward, thus requiring greater height than is now usual. Transition was soon made, however, to types of "terrapin-back" or "turtle-back" locomotives, bringing the motor much nearer to the ground, so that it could be coupled with the axles by means of connecting rods. In later types each axle of the locomotive has been connected with a separate and independent truck-mounted motor.

Modern mining locomotives range in size—according to the work they are designed to perform—anywhere from 2 to 20 tons, and their wheel gauges range from 18 inches to the standard railway gauge of 4 feet 8½ inches. The traction locomotive consists, broadly, of two iron frames within which are contained the motor and driving mechanism, the controller wheel being usually placed in front, vertically, within convenient reach of the motorman, who is seated; in some locomotives, however, the controller and hand wheel are placed on top of the locomotive, in a horizontal position. The motors are usually geared to the truck axles by means of cut steel gear wheels, and the traction wheels are shrunk and keyed upon the truck axles, being placed either inside or outside the locomotive frame. Electric headlights and mechanical brakes are used. The current is taken from an overhead copper trolley wire by a grooved brass trolley wheel, mounted on a short, stout trolley pole, and conveyed through the controller to the motors and back to the generators by means of the track rails, which are copper bonded, in order to insure a return circuit of thorough conductivity. A speed of from 6 to 10 miles per hour is usually made.

Because of the limited dimensions of ordinary mine entries and the light weight of rails, the 20-ton mining locomotive is about the largest that can be used to advantage. Greater hauling capacity is sometimes needed, however, and accordingly a double locomotive has been introduced, consisting of two standard 13-ton mining locomotives, one of which is provided with a 4-motor controller and a 4-motor commutating switch, so that the complete machine is operated from the one controller. Here again, mining practice harmonizes with that obtaining in electric railway work in the adoption of what is known as the "multiple-unit control," by means of which the control of motors over a whole train of vehicles can be brought to one point and there manipulated by one motorman, instead of being distributed, with each set under the control of a separate driver.

In an interesting paper, read before the Western Pennsylvania Central Mining Institute, in December, 1903, Mr. W. L. Affelder, superintendent of the Mosgrove coal works, in Pennsylvania, stated that a 10-ton 30-inch gauge "gondola" locomotive which had been in operation there for more than a year had never been idle a day on account of defect or accident. During that time it had hauled nearly 150,000 tons of coal, at a cost of less than one-tenth of a cent per ton for repairs. As many as 35 loaded cars, each weighing 3,700 pounds, are hauled by it up a grade of 3 per cent, 250 feet long. At a point in the mine where the grade is 4.5 per cent in favor of the load for 125 feet, and then 3 per cent for an equal distance, the locomotive holds back as many as 35 loaded cars with every car wheel running free.

Figures taken from various mines in the coal fields, and compiled by Mr. F. J. Platt, show a generally high degree of efficiency in electric haulage. At the Green Ridge colliery, Scranton, Pa., the cost of haulage by mule power was estimated at 7.15 cents per ton and the cost of electric haulage at 2.76 cents, showing a saving by electric haulage of 4.39 cents. At the Sturges shaft of the New York and Scranton Coal Company the cost for haulage by mule power was estimated at 6.58 cents per ton and the cost of electric haulage at 2.62 cents, showing a saving by electric haulage of 3.96 cents.

A special feature of electric haulage in mines is the use of "gathering" locomotives. In most coal mines the cars are gathered or collected from the working faces of the rooms by mules or horses, though in some low-veined mines where it is necessary to use very small cars they are pushed between the working faces and the "room necks" by the miners themselves. They are then collected by locomotives and hauled in trains to the tipple or shaft bottom. In many cases it has been difficult to enlarge the entries sufficiently to accommodate the mule, because of the cost of "brushing" the roof or "taking up the bottom," especially where a hard slate or rough limestone has to be dealt with. One means of obviating this difficulty has been found in the use of compressed air locomotives, but electricity has been found particularly suitable for this class of work. Locomotives used for this purpose are equipped with a reel which carries a flexible insulated cable. One end of this cable is connected to the trolley line, and the current is conveyed to the controller on the locomotive through a contact at the reel. The reel is geared up with the axles or truck of the locomotive, so that the cable can be paid out or coiled up. The gathering locomotive system can be pushed to a considerable distance from the end of the regular trolley circuit. An illustration of this class of work is to be found in the mines of the Jones and Laughlin Steel Company, at California, Pa. These mines have five 4-ton gathering locomotives. A train of empty cars is taken from the gathering junction and distributed by the motorman into the various rooms in his particular section of the mine, and on the return trip the loaded cars are gathered up. When passing through the entry the locomotive receives its current by means of a regular trolley pole, but when entering the room neck the pole is fastened down and the insulated flexible cable is hooked onto the end of the trolley wire, the rail still serving as the return circuit. It is stated that a crew of two men on such a locomotive can gather up from 100 to 120 cars, or from 300 to 350 tons of coal, in an eight-hour shift. One well-known mine has equipped its gathering locomotives with a separate truck or tender for carrying and operating automatically the cable reel; this, however, is not the preferred practice.

In the case above referred to mining locomotives are spoken of as operating with overhead trolley connections. There are instances, however, in which the third-rail method has been applied to such work. This type of rail is used not only for the conveyance of the current, but always also as a tooth rail, with which a geared wheel on the locomotive can engage frictionally. According to Mr. Affelder, in his paper already referred to, 90 electric locomotives of this sprocket or cog rail type are now in use in coal mines. As a means of climbing grades the electric locomotive possesses advantages which have caused it to be adopted in various parts of the world, subject only to questions as to the advisability of using the cogged third rail also as a conductor for the current. The first of the third and traction rail locomotives of the sprocket type appears to have been installed in this country in 1899 in the Star City (Indiana) mine of the Harder and Hafer Company, of Chicago.

In metalliferous mines, as distinguished from coal mines, the locomotive is usually smaller. An instance of such work is to be found in the haulage system of the United Gold Mines Company, of Victor, Colo.—the Cripple Creek district—where one 8-ton locomotive with a drawbar pull of about 3,500 pounds and a speed of from 8 to 10 miles per hour is used. This locomotive is equipped with a single high speed motor, placed in the center and on top of the frame, the motor shaft being connected to the drivers by gears. Current for this locomotive is generated at a waterpower plant 12 miles distant by a 3-phase alternating-current dynamo, transmitted at a pressure of 13,000 volts, stepped down and rectified at a substation, and delivered to the trolley at 550 volts direct current.

It is, therefore, not to be understood that electric locomotives find their only employment in coal mines. An interesting illustration of the extensive application of the electric mine locomotive is to be found also in the Quincy copper mine, at Hancock, Mich. The Quincy company has installed 15 electric locomotives, one of which is on the 4,400-foot level, current being supplied from the surface through substation transformer plants located underground. Another instance which might be quoted is the 8-ton mine locomotive at the Highland Boy Gold Mining Company's mine, at Murray, Utah, employed for hauling slag cars, and using double overhead trolley, so as to dispense entirely with the track as a return circuit.

Thus far the subject of mine traction has been considered from the point of locomotives supplied by overhead or underrunning trolleys, or by third rail, with current from a distant source of supply. It is possible, however, to employ self-propelling or automobile locomotives, equipped with storage batteries, so as to dispense entirely with the dangers and inconvenience of tracks and wires charged with exposed live current. The weight of the battery and the space that it necessarily occupies, however, increase the size and weight of the locomotives, and thus place a restriction upon this method of traction in many mining operations. Their use is therefore more particularly to be noted in connection with exterior work, and locomotives used for such work have considerable haulage capacity.

Several types of this locomotive are in use, either as simple automobile locomotives or as a combination vehicle employing the trolley over sections of the track where such use is permissible and safe. One well-known American manufacturer builds a locomotive of this type in which the batteries are carried upon a separate truck or tender, thus reducing the height of the locomotive to a minimum. This locomotive can be used for "gathering" purposes in low-veined coal mines, but its hauling capacity is necessarily limited, and by some authorities it is not considered feasible. In another type the batteries are mounted on the locomotive and are so arranged that the cells can be charged while the motors are being driven by current directly from the trolley wire. A smaller size of automobile locomotive is especially adapted to run on curves with a radius of 12 feet and a 21½-inch gauge. The current is estimated to cost about 50 cents per day of ten hours for a locomotive weighing from 4 to 6 tons and up to $1.50 per day for a 16-ton standard gauge locomotive. As a rule, the batteries are not worked quite so hard as those for regular automobile purposes, the requirements per pound of lead, instead of about 7 watts, being not more than 2 or 3. The advantages claimed for the battery, as compared with the trolley system, are that it can be run over any improvised track of appropriate gauge regardless of wire connections; that the first cost of the battery is usually less than the outlay on trolley wires and supports, including erection; and that the expenses of maintenance with good batteries also average lower.

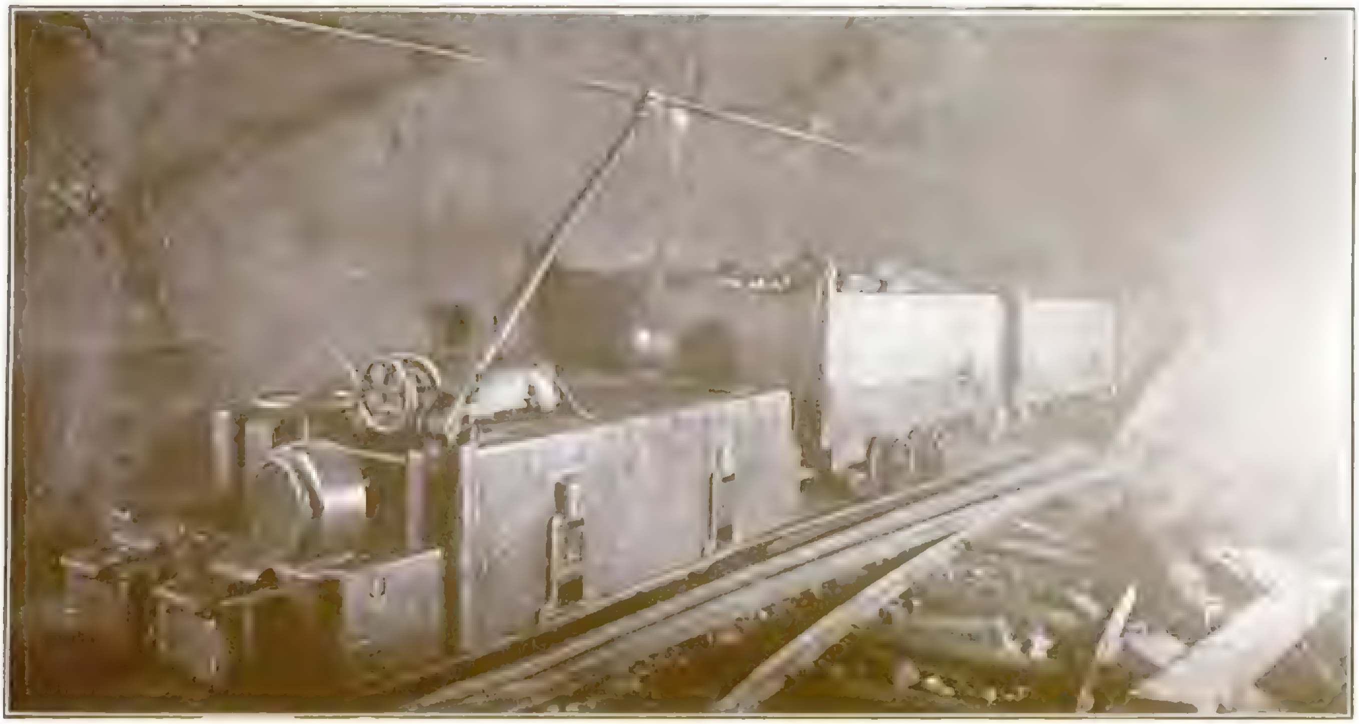

PLATE V.—TROLLEY ELECTRIC LOCOMOTIVE IN COAL MINE.

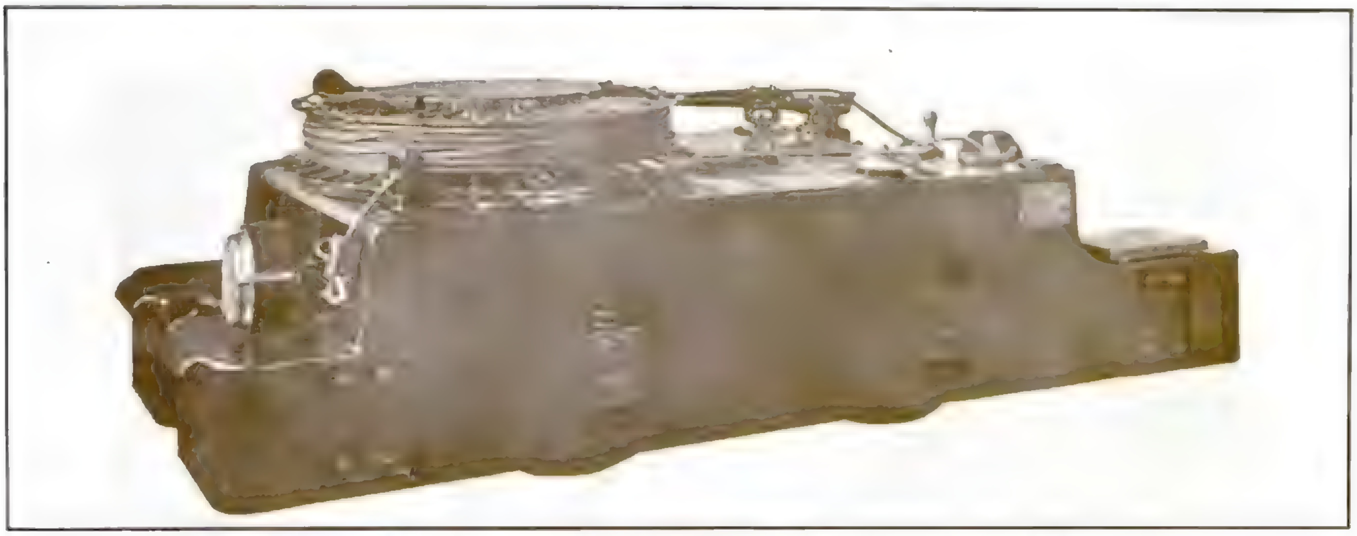

PLATE VI.—ELECTRIC MINE LOCOMOTIVE WITH REEL OF WIRE, FOR FLEXIBLE CONNECTION TO CIRCUIT.

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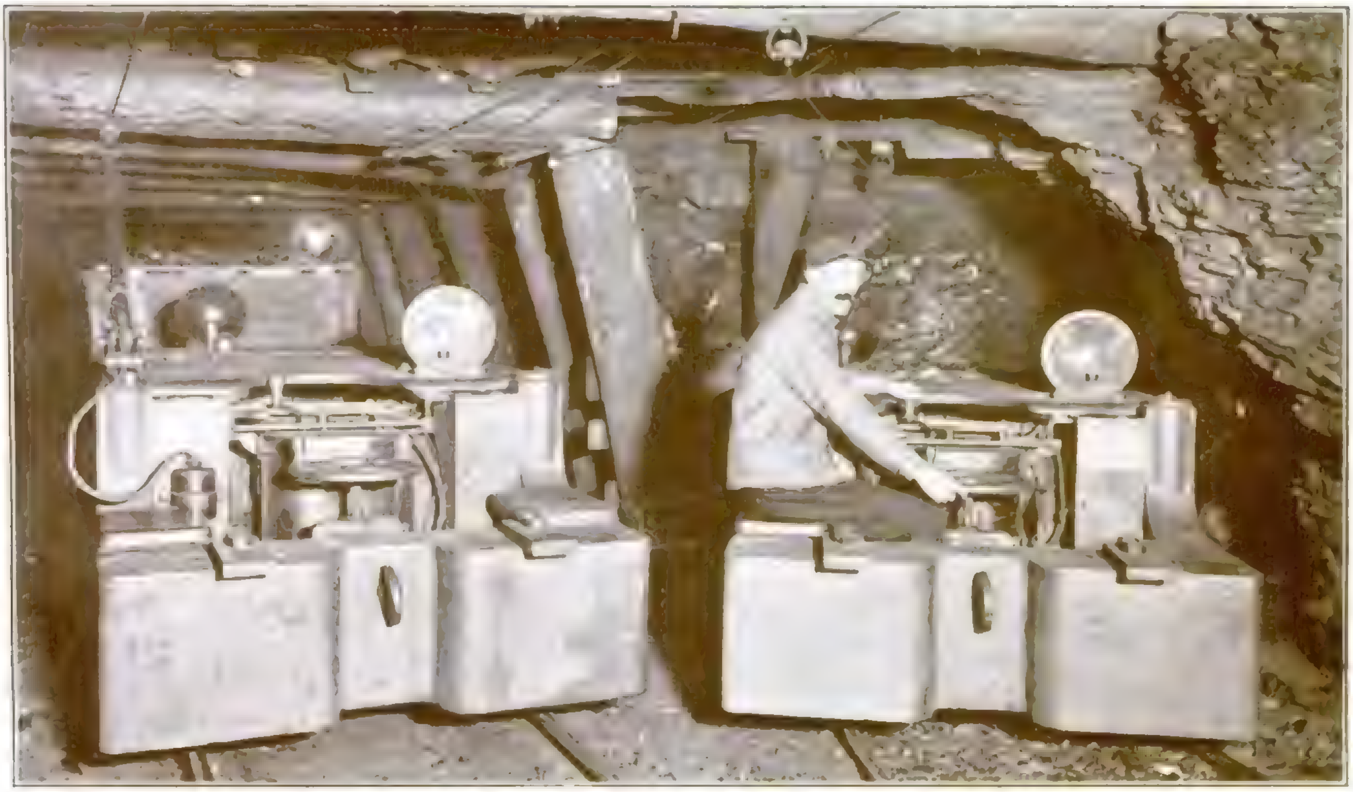

PLATE VII.—TWO 250-VOLT ELECTRIC LOCOMOTIVES IN COAL MINES AT KINGSTON, PENNSYLVANIA.

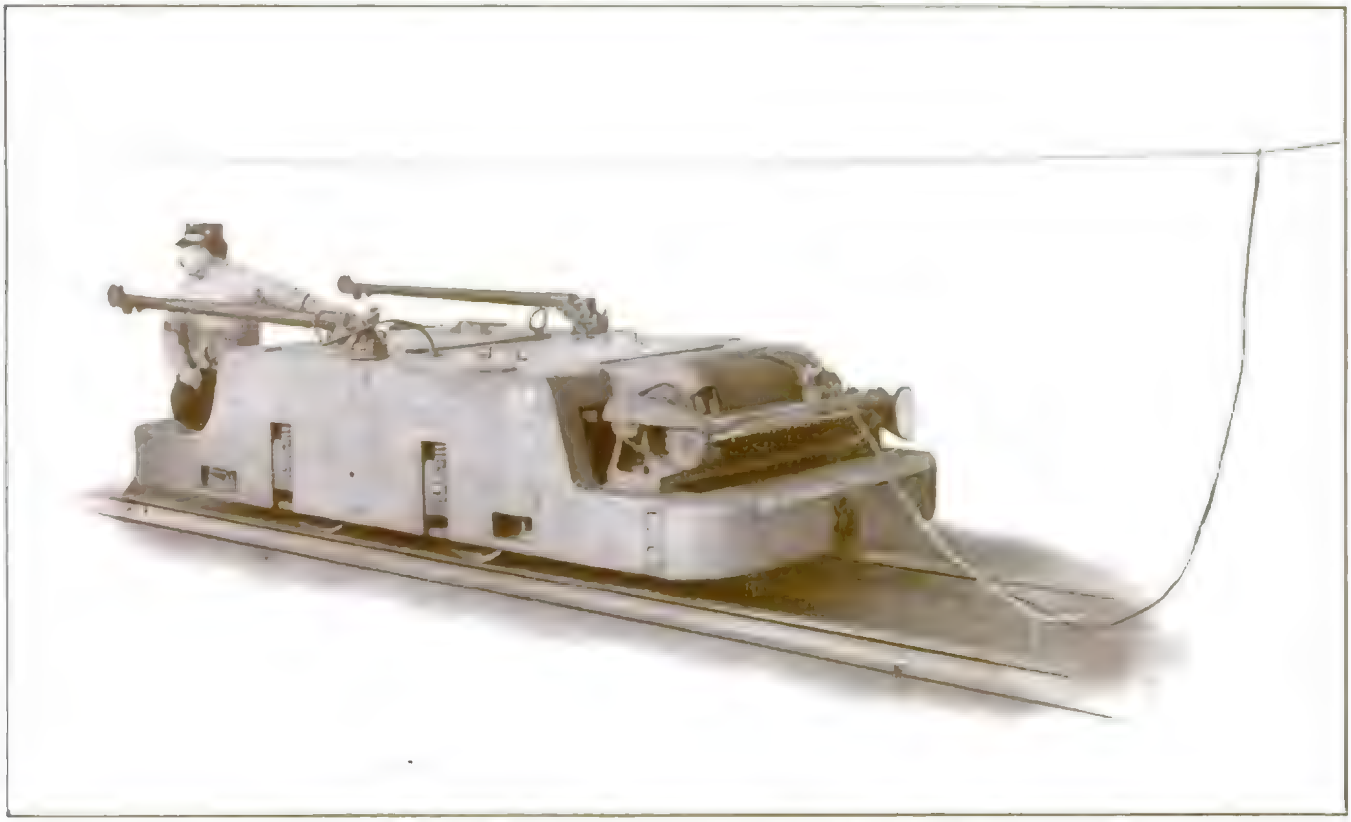

PLATE VIII.—ELECTRIC LOCOMOTIVE WITH REEL FOR AN EXTENSION CABLE.

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A further modification of traction or haulage methods is found in the movable automatic loader used by the Illinois Steel Company. It is difficult to classify this apparatus, but it serves to move ore, and therefore belongs possibly as much in the transportation as in the loading group. The machine consists of an endless chain of metal arms or scoops mounted on a stout metal table or base, which in turn is mounted pivotally on a truck, to enable it to adjust itself to the pitch of the ground and to the height to which the material is to be elevated in loading as, for example, to a line of the trolley mine cars. The chain of scoops, which is driven by an electric motor, passes around sprockets arranged at the opposite ends of the machine. The motor, which takes current through a cable reel from an adjacent trolley or other circuit, also propels the loader, moving it to any desired point by means of chain sprockets and suitable clutches. In operation the front edge of the table of the machine is lowered until it rests upon the ground, and it is then thrust forward against the pile of material. As the arms sweep around each arm or scoop gathers up a certain quantity of material and carries it into channels on the table until it reaches the upper end of the machine, when it is emptied into the desired receptacle. The arms travel at the rate of about 60 to 80 feet per minute, and the capacity of the machine is reported as 90 cubic feet of loose material per minute. This machine is said to have been tested successfully in the handling of limestone, coal, and salt, and to have shown a considerable saving of time and money over hand labor with a shovel.

Telpherage. An interesting and novel application of electric traction methods is to be found in the modern telpherage system. Up to the present time haulage of ores and other raw material in connection with mining work has often been conducted aerially, by means of a traveling wire rope or cable; and this use of the wire rope represents, in the aggregate, an enormous amount of work. As generally understood, a short stretch of such work, often with a span of several hundred feet between the supports, or between the support and the anchorage, constitutes a "cableway;" in this manner a river or a wide valley is bridged. A "tramway" cable, on the other hand, has frequent supports, and may be several miles in length. Electric telpherage belongs generically in the latter class, as it is not suited to very steep grades.

The fundamental difference between electric telpherage and the traveling rope system is that in the former case all the ropes or cables are stationary, the haulage being effected by means of an electric motor or "telpher" traveling along one of the cables, and taking its current, by means of a short trolley pole, from a trolley wire above. In the simpler form the telpher travels along a flexible wire cable; for heavier work a rigid metal rail supported between posts is employed, and upon this loads up to 20,000 pounds in weight can be moved at a speed of from 800 to 1,500 feet per minute.

This telpherage method was first experimented with several years ago in England and America, but only within the last year or two has it been practically introduced in this country and abroad. Its present feasibility is due to improvements in motors which can stand exposure, in methods of control, in contact devices, in brackets, etc. In an electric telpher system employed in a limestone quarry in the island of Cuba, the telpher with its cars travels upon cables, except at eight curves, where solid rail is employed. The buckets, loaded with limestone and carried below the telpher, take along the cable a maximum load of 1,200 pounds, with a speed of from 12 to 15 miles per hour. Current is derived from a distant power plant, and to start the telpher all that is necessary is to close the switches at the ends of the system. This telpher travels automatically, but in the case of larger apparatus a cab is provided for a telpher man, as on an electric crane, so that he can travel with the load of coal, sulphur, phosphates, etc., and assist in loading and unloading.

Even where regular wire rope haulage, in the shape of cableways, tramways, and surface lines with rails is employed, it has been found feasible to replace with an electric motor the driving engine operating the drums of cable. A number of plants with electric cable haulage have been installed in South Africa, Japan, Europe, and other parts of the world, the hauling motor and cable drums being placed usually at the top of the incline, so as to raise the loaded cars. The speed in such work is usually from 4 to 6 feet per second on a grade of from 10 to 15 degrees.

Hoisting.—Electric hoisting is a growing feature of the use of electricity in mines, and a large amount of work has already been done in this field with the object of replacing the steam engine with the electric motor driven from a central plant. To quote a paper read by Mr. F. O. Blackwell before the American Institute of Mining Engineers, at Albany, in February, 1903, "The throttling of steam to control speed, the necessity for reversing the engine, the variation in steam pressure, the absence of condensing apparatus, the cooling and large clearance of cylinders, and the condensation and leakage of steam in pipes when doing no work are all against the steam hoisting engine. One of the largest hoisting engines in the world was recently tested and found to take 60 pounds of steam per indicated horsepower per hour. The electric motor, on the other hand, is ideal for intermittent work. It wastes absolutely no energy when at rest, there being no leakage or condensation. Its efficiency is high, from one-quarter load to twice full load." As a matter of fact this class of work touches closely that above referred to in connection with inclined traction haulage, for after all an elevator is virtually a railway with 100 per cent grade. With these equipments great care is

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taken to regulate and control the apparatus for safety purposes with safety and emergency brakes, etc.

One of the instances cited by Mr. Blackwell in his paper is that of a flat rope double-reel hoist operating in the Free Silver mine, at Aspen, Colo. In this case the hoist works in a vertical single-compartment shaft, with guides for extra weight, and is driven by a direct-current motor of 120 horsepower at 650 revolutions per minute, with different gears to give 20 and 32 revolutions to the drum. The speed of hoisting ore is from 315 to 630 feet per minute, and that of bailing water from 510 to 1,020 feet per minute.

In one gold mine where steampower has been superseded by an alternating current induction motor, the hoist moves through the shaft at the rate of 1,250 feet per minute, double deck cages carrying 3,600 pounds of ore, thus elevating 500 tons daily from a 2,500-foot level. It is stated that this system has shown a net efficiency of 75 per cent, taking into account all electrical and frictional losses, and that the average cost per horsepower per month has been reduced from not less than $20 to $7.

Another illustration of an electric motor mine hoist is furnished by the plant installed in one of the pits of the Gelsenkirchener Bergwerks-Aktiengesellschaft, in Germany. This equipment is designed to raise in one lift, when working at its maximum capacity, a load of 4 tons of coal at a speed of 65 feet per second. The daily hoisting capacity in sixteen effective hoisting hours would be 2,700 tons with a single unloading platform, 3,200 tons with two platforms, and 4,000 tons with three platforms from a depth of 1,641 feet. The two cages are attached to an endless rope which at the top passes half around and fits into an oak-lined sheath on the circumference of a drum 20 feet in diameter. On each side of the winding is a direct current motor, the current supply of which includes a storage battery.

Another interesting hoisting equipment is that installed in the Fortschrittschacht-Brüx mine, Bohemia, where the hoisting engine is driven by a direct current motor of 80 horsepower, with two winding drums, which hoist from a depth of 969 feet at a speed of 787 feet per minute with a single layer of steel rope, the gross load being not quite 4 tons.

Still another instance is the hoisting engine driven by an alternating current induction motor of 120 horsepower, installed in the Germania colliery, in Westphalia, Germany. The winding drums are each 3 feet 8½ inches in diameter, revolving through double reduction gearing at the rate of 16 revolutions per minute. The motor, which develops 200 horsepower at the beginning of the hoist, winds a normal load of 1¾ tons from a depth of 1,500 feet at a speed of nearly 10 feet per second; the load can be increased to 3¼ tons, however, with a corresponding decrease in speed.

A large hoist, with winding drums 19 feet 8 inches in diameter, erected for the Harpener Mining Company, at Dortmund, Germany, lifts 100 tons of coal per hour from a depth of 2,300 feet at a speed of 52½ feet per second.

Another interesting illustration is the plant recently constructed for the famous Comstock mine, at Virginia City, Nev. The power plant is situated on the Truckee river, 32 miles from the mine, and the present substation is located at Virginia City. Electric hoists are used extensively, the largest being of the balanced tail-rope system, driven by a 200-horsepower variable-speed alternating current induction motor.

Pumping.—Electric motors have been found extremely useful and successful in a large number of cases for driving the pumps which are employed to remove the accumulations of water in mines. It is said that the efficiency even of small reciprocating pumps is not far from 80 per cent, and that large pumps give as high as 90 per cent.

One of the problems encountered in connection with this application of electricity has been the proper regulation of the speed of the motors for the purpose of varying the amount of water pumped. In direct current motors this is done by varying the field strength; the electric pumps which have been in operation for ten years past in the Calumet and Hecla copper mines, in Michigan, have adjustments of speed of 2 to 1 under this system. When induction motors are used the windings are thrown into different combinations for various numbers of poles and rates of speed, and several frequencies, also, are provided for. Some alternating current motors employed in electric pumping operations are of noteworthy size, developing as much as 650 to 750 horsepower.

For electric pumping the pump itself need embody no special features. Both reciprocating and rotary pumps are used; they may be either horizontal or vertical, and reciprocating pumps may be of either piston or plunger type, according to the circumstances of the installation. Where a reciprocating engine is employed, however, it is generally considered advisable to use a double acting pump, either duplex or triplex. A triplex double acting pump does not require so large a motor as does a simplex acting pump doing the same duty. To raise a great quantity of water against a certain head takes just so much power, but if the work be divided among two or three acting cylinders there will necessarily be a more uniform flow of water, and hence the strain on the motor and the pump will be reduced.

No fewer than 50 electrically driven pumps of the reciprocating class are in operation in the mines around Johannesburg, South Africa, some of them delivering as much as 200 gallons per minute working against a 500-foot head. A striking illustration of electric pumping work is furnished by the Arniston colliery, near Edinburgh, Scotland. One set of pumps of the 3-throw type, with 11-inch rams and 18-inch stroke,

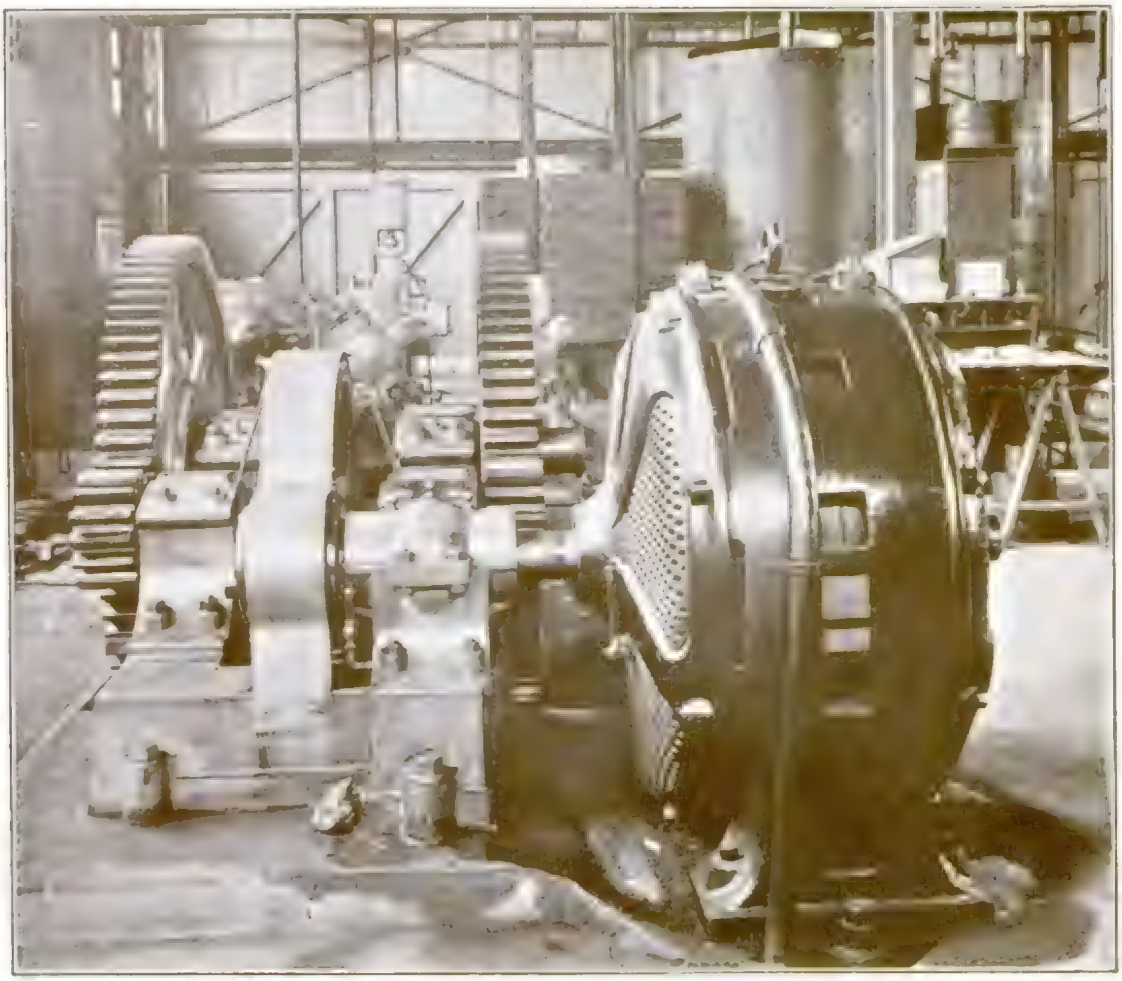

PLATE IX.—MINE PUMP, DRIVEN BY A 150-HORSEPOWER MOTOR.

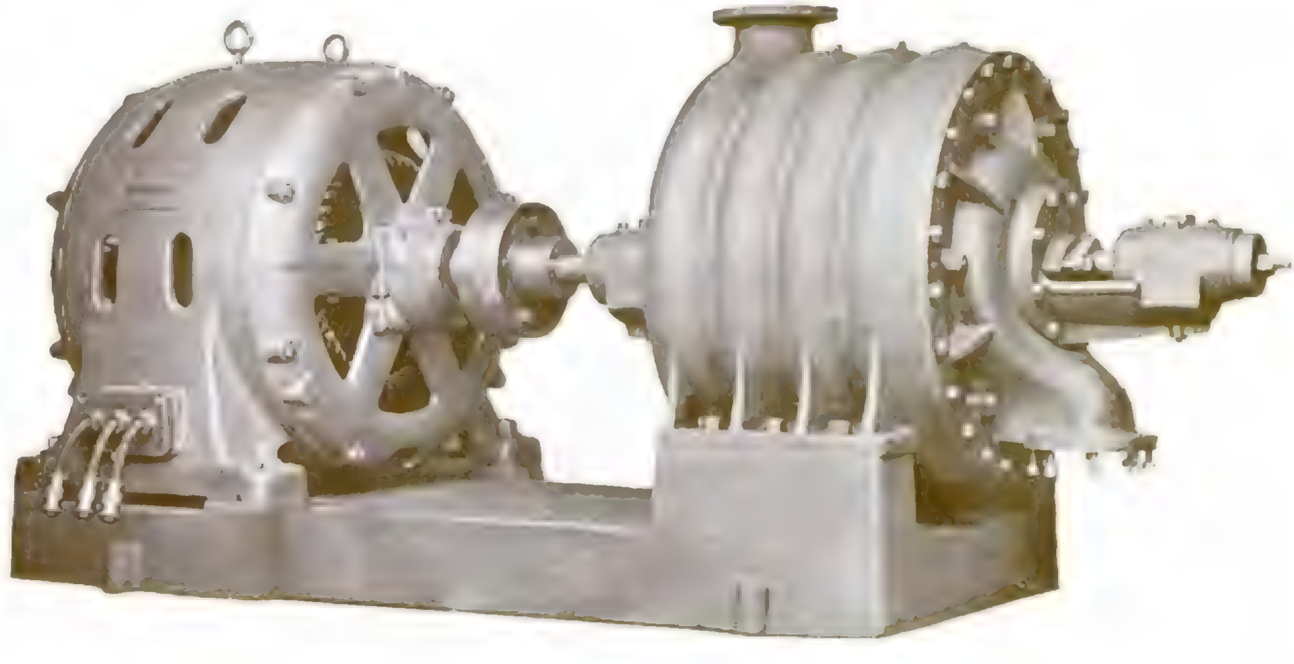

PLATE X.—FOUR-STAGE MINE PUMP, DRIVEN BY A 150-HORSEPOWER MOTOR.

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delivers 500 gallons per minute against a head of 678 feet. Each of these pumps is driven by an 80-horsepower motor and runs with a speed of about 30 revolutions per minute. Another set of pumps, similar to the above, delivers 500 gallons per minute against a head of 256 feet through 3,175 feet of cast iron pipe. These pumps are of the same diameter and stroke as the others, and are equipped with 80-horsepower motors. Three sets of pumps have also been installed to the dip, each set capable of delivering 100 gallons per minute against a head of 450 feet. These pumps deliver through 1,200 feet of 6-inch pipe, 9-inch stroke, and are equipped with 25-horsepower motors.

On the continent of Europe what are known as express pumps have been largely installed, the name being applied generally to any reciprocating pump run at high piston speed, although applied also to a special system of large, high-speed pumps with mechanically closed suction valves. An example of an electrically driven express pump in mining is one in Bohemia, which runs at the comparatively high speed of 200 revolutions per minute and is capable of lifting 132 gallons per minute against a head of 1,312 feet.

On account of its rotary motion and its high speed, approximating the speed of a motor, the centrifugal pump also is peculiarly suited for electrical operation, the pump and motor being usually direct connected. This pump has been found of special utility in working against low heads and for handling muddy water.

The use of rotary pumps coupled direct to small motors running at high speed in place of reciprocating ram or plunger pumps has met with approval in Europe. These rotary pumps are made with several chambers placed in tandem and are of a type between an ordinary centrifugal pump and a form of reverse turbine. One built in Germany has 4 chambers and 4 impellers and is coupled direct to an alternating current motor of about 85 horsepower, which, when run at 1,335 revolutions per minute, has lifted 440 gallons of water per minute to a height of 394 feet. By increasing the number of impellers to 6, this pump can be made to reach 1,150 feet in one lift. An efficiency of between 70 and 75 per cent is claimed for this type of pump.

Another type of electric pump is the sinking pump. The electric sinking pump can be lowered from one location to another in much less time than a steam or compressed air pump, and as it can be completely submerged it does not have to be relocated as often as a steam pump. The question of what would happen to an electric motor in a mine if pumps and motors get flooded has often come up. From tests made recently at the University of Liége, Belgium, it appears that a suitably designed polyphase alternating current motor will suffer very little damage. A 3-phase mining motor of a type largely used on the continent of Europe was completely submerged in water. It was run for a quarter of an hour; it was then stopped and allowed to remain submerged, under official seal, for twenty-four hours, at the end of which time it was again run for a few minutes. It was next removed from the water, again put under seal, and left to dry for twenty-four hours. The insulation was then tested, and the motor was found to be in perfect order. It would be hard to imagine a test more severe than this.

As bearing upon this question it is interesting to note that among the pumps in use around Johannesburg, South Africa, at the beginning of the Anglo-Boer War, there were twelve of a well-known American make, each of which was operated by a 50-horsepower induction motor of American construction with three 15-kilowatt transformers. When the mines were shut down, upon the breaking out of the war, the water rose so rapidly that it was impossible to remove the pumps, motors, transformers, etc., and consequently they remained under 500 to 1,000 feet of water. Two and a half years later, when peace was declared in South Africa, the water in the shaft was pumped out and the electrical apparatus was removed to the surface. Three of the motors were stripped and completely rewound, but to the general surprise of the experts the condition of the insulation indicated that the rewinding might not be absolutely necessary. Accordingly the other nine motors were thoroughly dried in an oven and then soaked in oil. After this treatment they were rigidly tested, proved to be all right, and were at once restored to regular service in the mine. The transformers were treated in the same manner as the motors, with equally gratifying results.

An interesting illustration of the flexibility and adaptability of electric motors for pumping purposes is furnished by the Gneisenau mine, near Dortmund, Germany, where a very large electric mining plant was installed in 1903. In this instance the pump is located more than 1,200 feet below the surface, and the difficulties of installing the apparatus were so great, on account of the small cross section of the shaft, that it was necessary to build up the motor in the pumping chamber, the material being transported through the wet shaft and the winding of the coils being performed *in situ*.

An interesting use of the electric pump associated with the telephone in connection with mining is noted by Mr. W. B. Clarke. In one coal mine, where an electric pump is located in a worked out portion of the mine, the circuits are so arranged that the pump is started from the power house, some distance away. Near the pump is placed a telephone transmitter connected to a receiver in the power house. To start the motors, or to ascertain whether the pumps are working properly, the engineer merely listens at the telephone receiver, without leaving his post.

Lighting.—From the earliest days of practical electric lighting, the availability of the method for mining was recognized; and electric illumination in some form or other is now used very widely. Of the two forms—the arc and the incandescent—the latter is very naturally preferred underground, for various reasons. In the first place, the subterranean spaces to be illuminated are restricted in area, so that small lights are sufficient; in the second place, both the earlier arc lighting circuits and a great many of those in use to-day have involved the employment of dangerously high pressures; and in the third place, there is objection to employing underground an open-flame lamp, such as the ordinary arc lamp has always been. Hence, while a large number of mining plants utilize arc lamps, these are to be found above ground, while the lighting below the surface depends upon incandescents. The advantages claimed for incandescent electric lighting are: The flexibility of the system, making it possible to move circuits readily from one part of the mine to another, the absence of fumes and smoke, less danger of fire, decreased cost, generally better lighting, and reliability of the light under all the variations of temperature and barometric pressure.

It follows that the electric lighting in mines is usually of a composite type, the arc lamp being used at the surface, in buildings, yards, sidings, outworks, etc., while the incandescent lamp is used in the mains, levels, tunnels, etc. At one time, in order to accomplish this dual purpose, it was necessary to install two types of generating dynamos—one for the high-pressure arc lighting and the other for the low-pressure incandescent lighting; but the later developments and improvements in arc lights have made it possible to operate them on the same circuit as the incandescents and in conjunction with motors, and hence recent years have seen the installation of standard types of direct-current dynamos for all services, operating at voltages of 100, 220, 550 volts, etc.

The British departmental committee already cited laid down, with regard to the installation and use of electricity in mines, a few simple rules, aiming at continuity of service and the prevention of the escape of current. It is provided that for lighting purposes only low pressure shall be used, and that lamp holders, switches, or other fittings must not be fixed directly to the timber or metal work, but must be attached to hardwood or other incombustible, nonhygroscopic insulated base blocks. Small wires or derived circuits for lighting must be noninflammable or suspended from porcelain insulators, or fastened to them with some nonconducting material which will not cut the insulated covering and which will not permit the wires to touch any timber or metal work. Staples of all kinds are prohibited. If metallic pipes are used, they must be electrically continuous, and must be earthed or connected to ground. If separate uncased wires are used, they must be kept at least 2 inches apart, being brought together only at switches or fittings. Wire for lighting purposes underground is not to be of flexible cord; in other words, it is not to undergo the mechanical strain of supporting a lamp. It is especially required that in places where there is liability to fire damp, etc., incandescent lamps must be used, inclosed in gas-tight fittings of strong glass without any flexible cord connections, and with the wires protected by a strong exterior metallic sheathing, sufficiently grounded.

These general conditions are observed in all well-conducted mines, both in this country and in England, and special pains are taken with regard to the fittings, so as to protect the lamps from injury, and also to get as much light as possible from each lamp. Where the incandescent lamps are subject to vibration special types, with anchored filaments similar to those employed on trolley cars, are used.

One feature of electric lighting worthy of note, but not of great importance, is the use of portable miners' lamps. A great many efforts have been made in this direction with electricity, the lamps depending for their supply of current upon either primary or storage batteries. In either case, the drawbacks have been the weight, delicacy, high cost, and uncertainty of the apparatus, and the fact that such lamps are not usually of the safety type by which the presence of choke damp or other dangerous gases is revealed. In connection with these portable electric lamps for miners, small bulbs and filaments are used, so as to reduce the consumption of current to a minimum, thus making the batteries last longer.

Very few records of tests as to electric mine lighting are obtainable; in fact, very few such tests appear to have been made. The most important series is that made some six years ago in behalf of the Westphalian miners in the testing gallery of the consolidated collieries near Gelsenkirchen, dealing with the dangers that arise from the use of electrical appliances in gaseous mines. The results of the investigation, embodied in a report made public during the present year, may be summarized as follows:

Naked filaments raised to high incandescence may or may not cause explosions, and may remain intact and burn after explosion; in most cases ignition seems to follow the breakage or burning of the filament and the accompanying sparking. Lamps with their bulbs attached were purposely shattered, the bulbs and filaments breaking simultaneously and producing bad sparking, sometimes with and sometimes without an explosion. In other cases the filaments remained intact when the bulbs were smashed, and here again explosions sometimes followed and sometimes did not. Currents of not less than 9.6 amperes, continuous or alternating, did not produce ignition, but often produced sparking; stronger currents generally did give ignition.

Electric incandescent lamps are recommended, as affording probably the safest underground illumination. The conclusions as to lamps are: Use stout globes with round bulbs, to prevent cracking from the dripping of water on the hot bulbs: and for further protection, inclose them in wire cages. Use low-current lamps (maximum of 9.6 amperes) and high voltage—but not above 150 volts, for all excessive voltages are dangerous. Have short leading-in wires for the lamps, far apart, to guard against their being bent together and thus making a short circuit; for the same reason avoid lamps with two filaments in series. This summing up is against the common portable lamp, which has the further disadvantage of not indicating the presence of fire damp.

But little was done in these tests with arc lamps. They appear not to ignite coal dust, even in an atmosphere of 4 per cent of marsh gas, and it is noteworthy that a dust storm did not make the arc flare up; but in 6 per cent of marsh gas explosions took place, whether the lamp was already burning or was switched in. Arc lamps, both continuous and alternating, must be condemned for fiery mines, although it should be noted that arc lamps have been used with impunity in rubber works, where the air is saturated with benzine vapor.

As regards switches for one or more lamps, it was found that current strength, and still more the voltage and self-induction in the current, play an important part; and while in general slow switching in is dangerous, on account of arcs forming, rapid motion of the switch is to be avoided in the case of circuits with high self-induction, continuous or alternating. In some cases the switch was thrown 30 times before ignition occurred. Carbon points may glow without causing an explosion so long as there is no arc. Spark extinguishers which form a momentary arc are to be condemned.

Hot wire resistances seem in themselves harmless, but danger threatens from contact. A set of resistances was placed horizontally, and one hot spiral touching another caused an immediate explosion. Glowing wires did not cause explosions, even when the explosive atmosphere was driven through them by means of a fan; and an iron wire buried in coal dust and heated by the current until it arcked strongly did not ignite the dust, either when it was quiet or when it was stirred into a cloud. Fusing wires protected by a shunt may be considered harmless; but ordinary safety fuses of lead and tin acted poorly.

Ventilation.—A considerable amount of work is done in mines to-day in the way of ventilation by electric motors, the driving of ventilating fans and blowers by electricity having been found to possess many advantages. In addition to the large amount of work done in tunnels, there is considerable work done in galleries in the way of operating the main fans or blowers for the general ventilation of mines. The larger fans of this class are belt-driven, on account of their very low rates of speed, but the smaller ones are also to be found direct connected to the motors.

As pointed out by Mr. Daniel Burns, in his treatise on electricity in British mining practice, in most mines where galleries are driven some distance from the main airway it becomes difficult to ventilate properly by the ordinary methods. The ventilation of such places is always an important matter, especially in coal mines, where a considerable quantity of gas is likely to be given off. It can best be accomplished by placing a small fan at the entrance to the heading or drift, and by this means forcing in the required amount of air. The fans employed for this purpose are sometimes driven by belt from the motor, but in many instances the motor is direct connected. It is found desirable to inclose both the motor and the switches as thoroughly as possible, in order to minimize the possibility of explosions which might result from the gaseous conditions under which such ventilating systems may work.

The work of ventilation in galleries may be illustrated by the case of a Westphalian mine with a 40-horsepower motor driving a Pelzer fan, and producing 50,000 cubic feet of air per minute with a water gauge of 3 inches. The motor, which is of the alternating type, is located about half a mile from the generator. Another instance is the case of the Glückauf mine, at Sondershausen, Germany, where a belted motor of 100 horsepower has been installed to furnish the general ventilation, although the blower is in the immediate vicinity of the steam plant. Still another instance is the 400-horsepower polyphase motor employed in the Germania mine for general ventilation.

Placer mining.—A considerable amount of placer mining work has been done by electricity of late, particularly in the Western states. The best way to afford an idea of work of this character is to cite some of the later examples.

The Gold Pan Mining Company, of Breckenridge, Colo., which has the largest placer mining plant in the state, if not in the United States, depends chiefly upon electricity for its operation. The current is generated at a plant some 5 miles from the deposits and is carried to a substation at the mine at a line pressure of 10,000 volts, 3-phase alternating. It is used principally for the driving of pumps and the illumination of the works. Large bowlders are moved by two electrically driven portable cranes of the boom type, which use alternating current from the line, without transformation, and each of which is equipped with a motor capable of developing 30 horsepower. A large 150-horsepower constant-speed motor is used to drive a centrifugal pump which assists in keeping the pit dry. A large machine shop, in which are made the large wrought steel water mains employed in the placer system, is supplied with power by a 50-horsepower constant-speed motor.

In California the earliest placer mining, represented in a later stage by hydraulic working, upon which legislation imposed severe restrictions, has been largely superseded by dredging, which appears to have developed into a very profitable enterprise where power can be obtained cheaply. In fact, it is stated that, with cheap electric-power dredging, land in which the gold averages less than 10 cents to the cubic yard pays for treatment.

The gold bearing placer soil of California has a depth of from 10 to 50 feet, being a gravel deposit left in the old river channels. After one or two holes have been put down by drills, for test purposes, and an analysis of gold bearing soil made, the dredges are put to work should conditions warrant it. Two types of electric dredge are used to secure the gravel for treatment. In one method the gravel is lifted through centrifugal pumps, while in the other the method more generally used—it is handled by an endless chain of buckets.

The method of operation is very interesting. A boat is built in the basin or excavation where the operations are to be carried on, the necessary equipment is put on board, and the hole is then filled with water to a depth of from 25 to 40 feet. Current is brought to the operating motors on the boat by means of overhead wires and cables, the cable being usually run out from 400 to 500 feet from the shore. As a general thing, the current used is high pressure, alternating 2 or 3 phase, and the transformers for receiving it and stepping it down for use, although sometimes put on the boat, are generally placed on the bank, on a pole, or in a small substation. The dredge digs its own channel ahead of it, depositing behind it the soil which has been worked over. It may thus be said to carry its own little pool with it as the work shifts from point to point. The gravel is elevated into a grizzly or similar device, where the rocks are washed out of the soil and delivered to the carrier, which deposits them on the dump behind the dredger. The fine soil is next washed through shakers and riffles, the gold being deposited on saving tables, to be taken up with quicksilver, while the worked-over soil is deposited at the stern of the boat with the other residue.

Some idea of the character of the work may be formed from the equipment of the chain-bucket dredge operated by the Butte Gold Dredging Company. This dredge, which has a draft of 5 feet and is about 36 by 90 feet on the water line, is fitted with two spuds, each 50 feet long; one, of wood, weighing about 10 tons, and the other, of steel, weighing about 17 tons. The swing permits of a cut about 90 feet in width. There are 85 buckets to the chain, each bucket having a capacity of 5 cubic feet. The dredge is operated at a normal speed of 22 buckets per minute, and ordinarily will handle from 50,000 to 75,000 cubic yards of raw material per month. The stacker at the stern of the boat is about 90 feet long and 2½ feet wide.

The largest dredge yet installed is that of the Ashburton Mining Company, near Folsom, Cal., with 7½-foot buckets. Some idea of the electric power equipment may be formed from the fact that the induction motors for this dredge include one of 150 horsepower for the digger or bucket line, one of 20 horsepower for the winch, one of 75 horsepower for the centrifugal pump, one of 20 horsepower for the stacker, and one of 10 horsepower for the deck pump.

The Central Gold Dredging Company, of Oroville, Cal., has a typical equipment of motors of somewhat smaller size and greater variety, including one of 50 horsepower for driving the buckets, one of 15 horsepower for the winches, one of 40 horsepower for the centrifugal pump which delivers the water for washing the soil under treatment, one of 15 horsepower for driving the stacker or conveying belt which disposes of stones, one of 15 horsepower for the operation of the shaking screens, one of 3 horsepower for the deck and bilge pump, and one of 30 horsepower for operating the sand pump, which is used occasionally, when the sand accumulates too quickly at the back of the boat to deliver it out of the rock pile through a long pipe. The cost of operation in the Oroville territory, including the cost of electric power, maintenance, labor, repairs, and superintendence, but not including any allowance for depreciation or for interest on the investment, is estimated at from 5½ to 6 cents per cubic yard. The cost of power is estimated at 1½ cents per kilowatt hour metered. This seems low, but is an actual price. Some of the dredges operate 80 per cent of the time, and their electric power capacity and current consumption are indicated by the fact that the cost of current per month ranges from $800 to $1,200.

Miscellaneous use of electricity.—In addition to the more important applications of electricity to mining, already described, numerous applications of a miscellaneous character might be mentioned. The flexibility of electric circuits and the general adaptability of electric power have led to a wide range of applications, some of which are still in the experimental stage, while many others have already proved successful.

An instance may be found in the substitution of electric motors for steampower for driving air compressors, where the latter are still used for the operation of small tools, coal cutters, drills, etc. By this means the compressor can be placed conveniently near the point of application of the air, so as to avoid long and complicated systems of piping, with consequent inefficiency and heavy loss, whether of steam or of air. Electrically driven compressors sometimes have belt connections, but in many instances the motor and compressor are more directly connected. An alternating-current induction motor having a capacity of as much as 200 horsepower has been connected to the air compressor by spur gearing. In one California mine the installation of an electric motor to take the place of steampower for driving a 100-horsepower air compressor is reported to have reduced the average cost of operation per month from $1,800 to $672.

A novel and interesting application of electricity to mining is furnished in the large sand wheel equipment at the Calumet and Hecla mine, driven by a 700-horse-

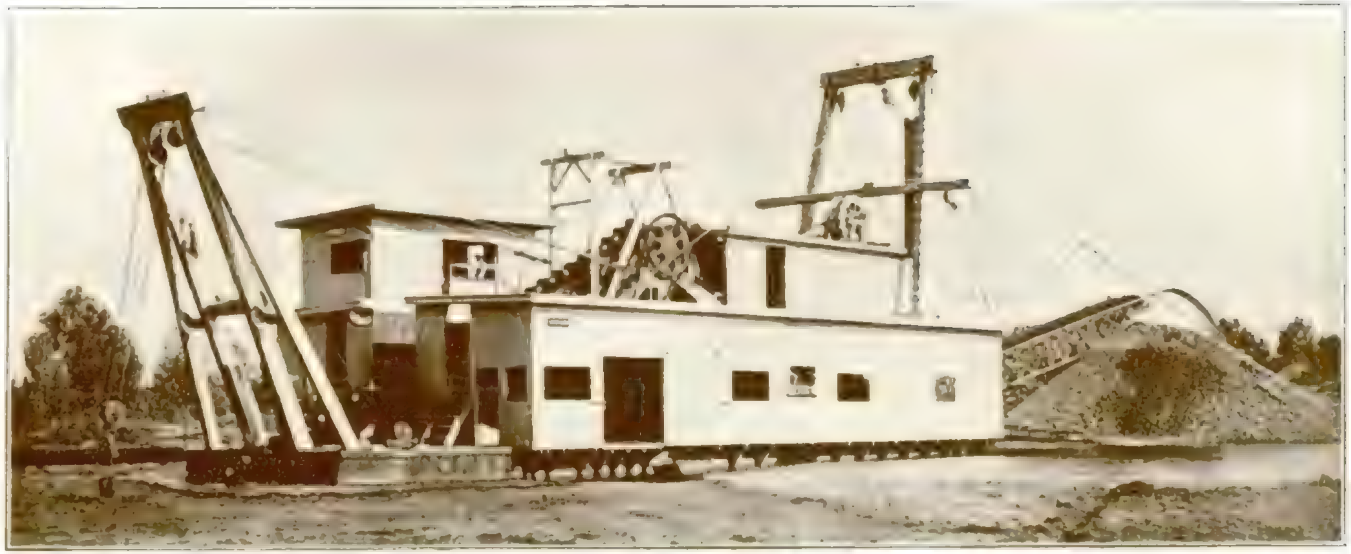

PLATE XI.—ELECTRIC GOLD DREDGER AT WORK IN CALIFORNIA.

UNIVER ILLINOIS

power induction motor. To the rim of this wheel, which revolves in its pit at a speed of 10 revolutions per minute, are attached about 550 buckets for lifting the sand from the copper ore crushings. The electric sand wheel is considered to effect a considerable economy over the previous methods.

Signaling in mines requires a great variety of apparatus, such as telephones, telegraphs, bells, and appliances for sending signals according to the indications upon a dial. Of late years the telephone has gained ground rapidly over other methods of signaling. Several telephone manufacturers in the United States make types of telephones intended for mining work, with special regard to conditions of exposure, damp, etc. The British committee referred to previously records the fact that all of the witnesses before it, except one, spoke in favor of electric signaling in the shaft. Although admitting the fact that the difficulties in mines are greater than those in buildings, on account of the juxtaposition of heavy power cables and the presence of moisture, the committee recommends that as a means of ready communication between the power house and the motor equipments underground—a matter of great importance—telephones be put in all permanently installed motor rooms, so as to enable the men in charge underground to inform the engineer at once of any breakdown of motors, machinery, etc., and, if necessary, obtain assistance speedily. The committee notes the fact that for many years bare wires had been in use for transmitting signals without causing a single accident, and that, in fact, they had frequently prevented accidents.

In addition to the apparatus already described, a variety of appliances are employed for counting wagons, indicating the level of water, and kindred uses.

MINES AND QUARRIES BY STATES AND TERRITORIES

MINES AND QUARRIES BY STATES AND TERRITORIES.

INTRODUCTORY STATEMENT.

At the census of 1870, when the statistics of mining were first presented separately, they were summarized to show the totals in each state for each mineral and for all minerals. This practice was not followed at the censuses of 1880 and 1890, and comparable data are available for only a few states and the principal minerals. The great diversity of minerals now produced, and the great and increasing importance of the mineral industry in many states, make a summarization of this character again desirable. The detailed statistics for all productive mines in each state and territory, irrespective of the character of the ore, are shown in Table 2, and for the active but nonproductive mines, in Table 14, on page 57.

In the following discussion of the statistics for mines, quarries, and natural-gas and petroleum wells for each state, the states and territories are considered in alphabetical order. For each state a table is first presented, which shows the principal items for each of the leading minerals, and for all other minerals produced in commercial quantities during 1902. This table is followed by a general description of the state's mineral resources, and a summary of the statistics for the active but nonproductive mines. A brief résumé is also given of the products of manufactures that are closely allied to, or based on, the mining industry, because of the use of the products of mines as raw materials. The value of the production of the leading minerals is shown for a series of years, and the nature, occurrence, and history of each is discussed, together with a statement of the relative importance of the state in its production.

ALABAMA.

Table 1 is a summary of the statistics of the productive mines and quarries in the state of Alabama for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous.	Iron ore.	Limestones and dolomites.	Sandstones and quartzites.	Clay.	All other minerals.[1]
Number of mines or quarries	239	145	39	32	7	5	11
Number of operators	172	91	31	29	7	5	9
Salaried officials, clerks, etc.:							
Number	947	623	227	63	6	....	28
Salaries	$979,117	$709,149	$188,141	$54,367	$2,480	....	$24,980
Wage-earners:							
Average number	19,132	12,930	4,864	1,007	53	33	245
Wages	$10,345,118	$7,841,457	$2,030,807	$354,778	$29,433	$9,634	$79,009
Contract work	$267,279	$265,579	$400	....	....	....	$1,300
Miscellaneous expenses	$858,851	$731,972	$88,008	$25,364	$1,535	$3,866	$4,516
Cost of supplies and materials	$2,043,914	$1,219,310	$592,296	$149,012	$5,230	$1,983	$76,083
Value of product	$17,367,992	$12,419,666	$3,926,812	$759,037	$42,706	$19,712	$180,449

[1] Includes operators as follows: Bauxite, 1 (3 mines); cement, 1; gold, 4; graphite, 1; marble, 1; and pyrites, 1.

Alabama is especially rich in coal and iron, ranking fifth among the states in coal production and third in iron ore. It is also a producer of limestones and dolomites, sandstones and quartzites, clay, gold and silver, bauxite, graphite, marble, and pyrites. Extensive deposits of phosphate exist in what is locally known as the "black belt" extending across the central portion of the state. The phosphatic marls have very nearly the same percentage of phosphate and carbonate of lime as the Greensand marls of New Jersey.[1] In 1900 there was a production of 334 long tons of phosphate rock of a value of $544.[2]

Soapstone, as well as kaolin, is found throughout the metamorphic region of the state, large outcroppings that give very satisfactory results under fire tests occurring in Tallapoosa, Randolph, and Clay counties; these show indications of value for furnace linings.[3] The Indians made use of soapstone in many localities in the manufacture of various utensils. Not far from Tallahassee Falls there was the old Indian village, Tuckabatcha, near an outcropping of this mineral worked by them.

Tantalite has been found in the vicinity of Rockford, Coosa county, and a considerable amount has been sold for cabinet specimens. Tin found near Ashland, in Clay county, was mined at the Broad Arrow mines in 1883. The ore exists in considerable quantity, but is associated with titaniferous iron and can not be obtained in a sufficiently pure state to be marketable. Very pure specimens of tin ore were found, in 1880, near Rockford, in Coosa county, in association with tourmaline, biotite, and tantalite.[4]

Other minerals found in the state but not reported as commercially mined in 1902 are as follows: Beryl and feldspar, found in Coosa county; copper, in the old Woods or Copper Hill mine, in Cleburne county, which was worked awhile in the seventies, and is said to contain extensive ore bodies; and mica, formerly mined at Pinetucky, in Randolph county.

Development work was reported by 5 operators engaged in the development of gold and silver, bituminous coal, and iron ore deposits. They gave employment during the year to 10 salaried officials, clerks, etc., who received $9,010 in salaries, and to 45 wage-earners, who were paid $15,244 in wages. The miscellaneous expenses amounted to $889, and the cost of supplies and materials to $1,048.

Table 2 shows the value of the products of the manufacturing industries of the state, based primarily upon minerals mined and quarried, and the value of all products manufactured in Alabama in 1900.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of products.	
All manufactures		$80,741,449
Based upon products of mines or quarries:		
Chemicals and allied products	$2,068,162	
Clay, glass, and stone products	1,182,611	
Iron and steel and their products	22,980,924	
Metals and metal products, other than iron and steel	387,619	
Miscellaneous industries	5,685,801	
		32,305,117
All other		48,436,332

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[1] United States Geological Survey, "Mineral Resources of the United States," 1883–84, page 794 ff.

[2] Ibid., 1900, page 813.

[3] Transactions of the American Institute of Mining Engineers, Vol. X, page 204.

[4] Alabama Geological Survey, Bulletin No. 1.

As shown in Table 2, the value of the manufactures based primarily on minerals mined or quarried amounted to $32,705,117, or 40.5 per cent of the total value of all manufactured products in 1900. The combined value of the products of mines and quarries in Alabama in 1902 and of manufactures in 1900 was $98,109,441, of which amount the manufactures contributed 82.3 per cent and mines and quarries 17.7 per cent.

The average number of wage-earners in Alabama engaged in manufacturing, as reported at the Twelfth Census, was 52,902, and the wages paid amounted to $15,130,419. In 1902 the average number of wage-earners reported as engaged in mining was 19,132, and the wages paid amounted to $10,345,148. The two industries together gave employment to an average of 72,034 wage-earners during the year and paid $25,475,567 in wages, manufactures accounting for 73.4 per cent of the wage-earners and 59.4 per cent of the wages, and mines and quarries accounting for 26.6 per cent of the wage-earners and 40.6 per cent of the wages.

Table 3, compiled from reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1889 to 1902.

TABLE 3.—*Value of annual production of principal minerals: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Iron ore.	Limestone.
1889	$5,061,180	$1,511,611	$324,814
1890	4,202,469	(1)	324,814
1891	5,087,596	(1)	300,000
1892	5,788,898	2,442,575	325,000
1893	5,096,792	1,490,259	205,000
1894	4,095,325	1,240,895	210,269
1895	5,126,822	1,460,000	222,424
1896	5,174,135	1,417,451	180,921
1897	6,192,085	1,546,543	221,811
1898	4,932,776	1,482,208	242,295
1899	8,256,562	2,664,600	364,636
1900	9,793,785	2,929,068	532,648
1901	10,000,892	2,567,719	692,423
1902	12,419,666	3,922,812	779,617

[1] Not reported.

Coal.—The coal fields of Alabama form the southern end of the great Appalachian basin, extending from near the northern boundary of Pennsylvania to Tuscaloosa, Ala. The Warrior is the principal field and underlies an area estimated at 7,810 square miles, or nearly ten times the combined areas of other fields in the state, known as the Cahaba and Coosa fields.[1] It is made up of beds in Jefferson, Walker, Winston, Tuscaloosa, Fayette, Marion, Blount, Cullman, and Etowah counties, and contains 23 regular seams, varying in thickness from a few inches to some 16 feet, the total thickness of all seams reaching in some places as high as 115 feet.[2] This is one of the richest coal fields in the world, the quantity of available merchantable coal being estimated at 108,394,000,000 tons—enough at the present rate of consumption to supply the world for over 270 years. The Cahaba field, the area of which has been estimated at 435 square miles, lies in St. Clair, Jefferson, Shelby, and Bibb counties, and the Coosa field, with an area of 415 square miles, embraces portions of Calhoun, St. Clair, and Shelby counties.[3]

The earliest notice of the use of Alabama coal appears in a letter written in 1834.[4] It was then brought down to Mobile from Tuscaloosa in flatboats and sold at the same price as the Liverpool coal, from $1 to $1.50 per barrel. In 1849 but three beds were worked underground, the rest of the coal being taken from the bed of the Warrior river and other streams during the low stages of the water. Before and during the Civil War the industry progressed slowly.

The coal and iron development of the state began about 1870, and with the exception of the panic years 1893–94 each year since has shown an increase in the coal production. The coal counties are Bibb, Blount, Cullman, Etowah, Jefferson, Marion, St. Clair, Shelby, Tuscaloosa, Walker, and Winston; but a little more than one-half of the coal is produced in Jefferson county and over 89 per cent in Jefferson, Walker, and Bibb counties. Cannel, lump, free burning, coking, and gas coals are produced. The manufacture of coke consumed 4,237,491 tons in 1902, 2,760,298 tons of which were made into coke at the mines.[5]

The following table shows the production of bituminous coal in Alabama from 1870 to 1902, inclusive, the figures being compiled from the reports of the United States Geological Survey, "Mineral Resources of the United States:"

TABLE 4.—*Annual production of coal, bituminous: 1870 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
Total	102,464,836	1886	1,800,000
1870	13,200	1887	1,950,000
1871	15,000	1888	2,900,000
1872	16,800	1889	3,572,983
1873	44,800	1890	4,090,409
1874	50,400	1891	4,759,781
1875	67,200	1892	5,529,312
1876	112,000	1893	5,136,935
1877	196,000	1894	4,397,178
1878	224,000	1895	5,693,775
1879	280,000	1896	5,748,697
1880	380,000	1897	5,893,770
1881	420,000	1898	6,535,283
1882	896,000	1899	7,593,416
1883	1,568,000	1900	8,394,275
1884	2,240,000	1901	9,099,052
1885	2,492,000	1902	10,354,570

Iron ore.—Almost all of the known ores of iron occur, but (except for small quantities of specular hematites, magnetites, and pyrite) only two are mined, the red hematite—Clinton fossil ore, red ore or Red Mountain ores—and limonite or brown ores. The red hematite or Clinton fossil ore belt has been the main dependence of the coke-iron industry.

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[1] Transactions of the American Institute of Mining Engineers, Vol. XIX, page 296.

[2] Alabama Geological Survey, Report on the Warrior Coal Basin, 1899, page 4.

[3] Transactions of the American Institute of Mining Engineers, Vol. XVII, page 207.

[4] Handbook of Alabama, by Saffold Berney, 1878, page 256.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 453.

The first iron furnace was built about 1818, a few miles west of Russellville, in Franklin county, and was abandoned in 1827.[1] A furnace was built at Polksville, in Calhoun county, in 1843, the Shelby furnace at Shelby, in Shelby county, in 1848, and one at Round mountain, in Cherokee county, in 1853. These were all charcoal furnaces, and were the only ones in Alabama enumerated by Leslie in 1856. The total product in that year was 1,495 gross tons of pig iron.[2] During the Civil War several new iron enterprises were undertaken, but it was not until about 1870 that the industrial development of the region of which Birmingham is the center set in. The history of Birmingham, which, in 1900, had a population of 38,415, dates from July, 1871, when it was laid out by the Ealyton Land Company.

The following table, compiled from the reports of the United States Geological Survey, shows the production of iron ore from 1889 to 1902:

TABLE 5.—*Annual production of iron ore, 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1889	1,570,319	1896	2,041,793
1890	1,897,815	1897	2,098,621
1891	1,986,830	1898	2,101,748
1892	2,312,071	1899	2,662,943
1893	1,742,410	1900	2,759,247
1894	1,493,086	1901	2,801,732
1895	2,199,390	1902	3,574,474

Limestones and dolomites.—The state has extensive deposits of limestone, and 38 quarries were in operation in 1902 in the counties of Blount, Calhoun, Colbert, Dekalb, Etowah, Franklin, Jackson, Jefferson, Lee, Shelby, and Talladega. Naturally the iron furnaces are the largest consumers of limestone as flux, and over 90 per cent of the state's output was for flux and lime burning. A dark, compact limestone occurs near Calera, Shelby county, and a light colored, finely fossiliferous one near Dickson, Colbert county.

Sandstones and quartzites.—The sandstone quarries are in the Potsdam sandstone, which has been opened in Colbert and Talladega counties, and in the sandstones of the Coal Measures. On the line of the Alabama Great Southern Railroad there occurs a yellow sandstone which is sufficiently soft to be cut with an ax, but hardens on exposure.

Clay.—Fire clays are common in the Coal Measures and also in the lowest Cretaceous beds. In the Tuscaloosa formation pottery or stoneware clays are found in Blount, Cherokee, Colbert, Elmore, Tuscaloosa, Pickens, Lamar, Fayette, Marion, and Franklin counties. China clays, kaolin, and ball clays have been found at Rock Run, Cherokee county; Gadsden, Etowah county; Kymulga, Talladega county; Fort Payne, Dekalb county; Chalk Bluff, Marion county; and Pegram, Colbert county. The kaolin found in many portions of the state is in purity all that could be desired. At New Jacksonville and 4 miles northeast of Louina, Randolph county, extensive beds occur. As the reported clay product of the state is only for clay dug or mined and sold as such, it is by no means a measure of the total volume of the product mined, since most of the manufacturers dig their own clay. The extent and diversity of the clay manufactures are shown by the fact that there were 93 establishments in 1900 in the classes of brick and tile and pottery, terra cotta and fire clay products, having a value of $883,129.

All other minerals.—The bauxite belt extends in a northeasterly and southwesterly direction through Cherokee, Etowah, Calhoun, Cleburne, and Talladega counties, with an average width of about 10 miles. It is at the bottom of the Knox dolomite of the Lower Silurian rocks.[3] As early as 1888 ore from near Anniston, in Calhoun county, was identified as bauxite and tested in iron furnaces as to its adaptability for furnace linings.[4] The deposits are all in pockets and are definitely connected with the numerous fault lines of the region. On the expiration of the patents under which the manufacture of aluminum is now held as a monopoly, the manufacture of this metal should be added to the industries of the state, since the state possesses both the ore and cheap power for electric generation. Numerous waterfalls and rapids are available for power, though the abundance and cheapness of coal has much retarded their utilization.

The state possesses all the materials for the manufacture of hydraulic cement, both from natural products (limestone and clay), and from basic slags and lime. Undoubtedly this is destined to be a growing industry. The state now has one Portland cement plant and two slag cement establishments.

Although the present gold yield is trifling, the extent of the auriferous deposits makes it probable that the gold mines of the state may again become of some importance. The state possesses an abundance of low-grade ores, which, with improved methods of concentration and extraction, may be worked profitably. The discovery of gold in Alabama followed soon after the gold discovery in Georgia in 1829, though there were no mint returns from the state until 1840. Gold is found in Cleburne, Clay, Talladega, Coosa, Chilton, Elmore, Tallapoosa, Chambers, and Randolph counties, both in quartz veins and surface gravel. All the earlier mining was placer, no attention being given to auriferous quartz until later. The chief districts were the Goldville district, Tallapoosa county, and the Arbacoochee district, Cleburne county, the latter at one time employing from 1,500 to 1,800 men in the placer mines. The total value of the gold and silver product to date, excluding that for 1895, which was not separately reported, is, according to the estimates of the Director of the Mint, $450,289, of which $365,300 was produced prior to 1880, the greatest product being between 1840 and 1849.

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[1] Annual Statistical Report of the American Iron and Steel Association, 1900, page 17.

[2] Iron in All Ages, by James M. Swank, page 293.

[3] United States Geological Survey, "Mineral Resources of the United States," 1892, page 237.

[4] The Mineral Industry, 1895, Vol. IV, page 49.

Graphite has been mined in Cleburne and Clay counties and largely used for furnace linings. The graphite mined in 1902 was from Clay county.

The state is rich in marbles, and a report of their production was made for 1902. A white marble occurs 4 miles west of Talladega and at several other points in the same county, and a black marble is obtained south of Talladega. Variegated marbles are widely distributed in the Tennessee valley, and the mountain limestone at many points is of great purity. The colors are gray with red veins, red and yellow, buff with fossils, and white crystalline clouded with red and black.[1]

Pyrite occurring in a semicrystalline state has been prospected in Clay county, and the pyrite output for 1902 came from this county.

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[1] Stones for Building and Decoration, by George P. Merrill, page 204.

ARIZONA.

Table 1 is a summary of the statistics of the producing mines and quarries of the territory of Arizona for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Copper.	Gold and silver.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	113	30	74	4	5
Number of operators	158	30	74	4	50
Salaried officials, clerks, etc.:					
Number	445	258	169	9	9
Salaries	$710,181	$399,273	$283,033	$16,775	$11,100
Wage-earners:					
Average number	5,323	3,797	1,442	32	52
Wages	$5,050,065	$3,497,528	$1,492,251	$21,922	$38,364
Contract work	$159,942	$122,337	$37,605		
Miscellaneous expenses	$392,205	$256,753	$114,046	$9,005	$12,401
Cost of supplies and materials	$3,060,521	$2,135,656	$873,091	$50,230	$1,544
Value of product	$11,197,375	$8,369,224	$2,704,677	$107,910	$15,564

[1] Includes operators as follows: Fluorspar, 2; lead and zinc, 1; precious stones, 46 (1 mica); siliceous crystalline rocks, 1.

Arizona ranks third among the states and territories in copper product, with a rapidly increasing output. The territory has extensive mineral deposits, and is famous for the number of its big copper camps—among them being Bisbee, Jerome, Clifton-Morenci, and Globe—and the deposits are not confined to one locality or district. It is also a large producer of gold and silver, and the agatized forest near the town of Holbrook is unique.

There are evidences of rude mining by prehistoric people at a number of points, and it is more than probable that the reduction of copper carbonates was practiced by the aborigines. Lieutenant Cushing discovered ancient oven furnaces in the Salt river valley near ancient copper quarries or pocket mines, with slag and charred grease wood in them, and tests of copper smelting which he made therein, produced copper buttons.[1] It seems likely that the iron ochers, malachites, and azurites were mined in a crude way for pigments, and prehistoric turquoise mines have been found at several points, notably in the Dragoon mountains.[2] The various canyons are said to afford sections of every geological formation known in America and present unsurpassed facilities for the study of the earth's crust to a great depth.[3]

In addition to the mines referred to in Table 1 and which were the source of commercial production in 1902, coal is found in the territory—the Deer Creek or San Carlos field having been known for many years but on account of its inaccessibility it has not been commercially worked. Extensive deposits of onyx on Big Bug creek, Yavapai county, were located in 1890, since which time the beds have been opened at many places there, and also at Cave creek. The colors are various shades of red, pink, brown, yellow, and green, the latter predominating. These have been worked to a considerable extent but were idle in 1902. Onyx marble in black and white occurs in Kirkland valley and also near Greaterville.[4] Tungsten was discovered in the Dragoon mountains near Benson, Cochise county, in 1896, and the domestic production in 1898 was chiefly from this locality. It is of the manganiferous variety known as hübnerite.[5] It also occurs in the Arivaca district, Pima county; in Mohave county, 16 miles south of Hackberry; and at the Mammoth mine in Pinal county. Gypsum deposits are found near Phoenix and at many other points. In the Santa Rita mountains, Pima county, extensive deposits of a thickness estimated at over 200 feet were discovered by Prof. W. P. Blake in 1896. Nickel has been reported as found in Pima county,[6] and quicksilver ore occurs near Copper Basin, Yavapai county.[7] Bismuth, magnesite, and molybdenum are also found.

There were 381 operators engaged in development work, without production, during the year, of whom 380 were reported for gold and silver and 1 for petroleum. These operators gave employment during the year to 386 salaried officials, clerks, etc., who received $459,452 in salaries and 2,246 wage-earners, who were paid $2,329,945 in wages. For work done by contract $197,324 was paid to 317 employees. The miscellaneous expenses amounted to $124,849 and the cost of supplies and materials to $924,313.

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[1] American Anthropologist, January, 1904, pages 95 and 96.

[2] The Copper Handbook, by Horace J. Stevens, page 100.

[3] Lippincott's Pronouncing Gazetteer of the World, page 523.

[4] United States Geological Survey, "Mineral Resources of the United States," 1900, page 775.

[5] The Mineral Industry, 1898, Vol. VII, page 719.

[6] Ibid., 1901, Vol. X, page 484.

[7] United States Geological Survey, "Mineral Resources of the United States," 1892, page 161.

Table 2 shows the value of the products of the manufacturing industries of the territory, based primarily upon minerals mined or quarried, and also the value of all products manufactured in Arizona in 1900.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of products.	
All manufactures		$21,315,189
Based upon products of mines or quarries		
Clay, glass, and stone products	$108,758	
Iron and steel and their products	49,975	
Metals and metal products, other than iron and steel	17,301,417	
Miscellaneous industries[1]	267,722	
		17,727,872
All other		3,587,317

[1] Includes products of 1 establishment under chemicals and allied products.

According to Table 2 the value of the products of manufactures, based primarily upon minerals mined or quarried, amounted to $17,727,872, or 83.2 per cent of the total. The total value of the product of mines and quarries in Arizona in 1902 and manufactures in 1900 was $32,512,564, of which amount mines and quarries contributed 34.4 per cent and manufactures 65.6 per cent.

The average number of wage-earners in Arizona engaged in mining, as reported for 1902, was 5,323 and the wages paid amounted to $5,059,065. The average number of wage-earners engaged in manufactures as reported at the Twelfth Census was 3,266, and the wages paid amounted to $2,369,065. Thus, the two industries together gave employment to an average of 8,589 wage-earners during the year and paid $7,428,130 in wages. Mines and quarries, therefore, gave employment to 62 per cent of the wage-earners and paid 68.1 per cent of the wages, while manufactures furnished employment to 38 per cent of the wage-earners and paid 31.9 per cent of the wages.

Copper.—Within the present area of the United States the first western smelting was done before the Gadsden Purchase, in New Mexico and Arizona, which were not separated until 1863. The copper mines in the Santa Rita mountains near Silver City, N. Mex., were actively worked and their ores smelted early in the century, and the first copper smelting done after the cession of New Mexico and Arizona and before the Civil War was at the Hanover mine. The copper bars were hauled to Galveston, Tex. Shortly afterward copper was mined on the Bill Williams Fork, Arizona, which empties into the Colorado at Aubrey. Most of it was shipped as ore, but there stood at Aubrey in 1895 an old ruined water-jacketed furnace of most odd design. There is no local tradition as to when it was used, and, therefore, it may represent the first attempt at water-jacketed furnaces, as applied to copper smelting.[1]

The Clifton copper district, now generally known as Clifton-Morenci, was discovered about 1865 and has been the scene of continuous mining since 1872. It is the oldest producing copper mining district in Arizona.[2] The first smelting was done in 1874 at the Longfellow mine, with a small Mexican adobe furnace, a blast being supplied by a common blacksmith's bellows.[3]

The second copper district to become productive was the Warren district, better known as the Bisbee mining camp, located in the Mule Pass mountains, Cochise county. It was originally discovered by Henry Warren, but it was not until 1879 that any work of moment was done. The first water-jacket furnace put up in Arizona, of which there is an authentic record, was erected in the autumn of 1880 at the since famous Copper Queen mine, which from that time to the present has been a famous producer.[4]

A great impetus has been given to mining in this district by the success of the Calumet and Arizona Mining Company in developing ore with deep mining. Although nothing of particular value was encountered above a depth of 700 feet, the immense ore bodies opened up below that level have made this property, which became a producer in 1902, one of the future great mines of the world.[5] The deep developments on an extensive scale inaugurated by a number of companies in this camp gives promise of a large increase in the copper product of the territory within the near future.

The Globe district in Gila county has been a large producer since 1882. The original discovery was made many years before, but no locations were made, as copper was at that time valueless in that inaccessible territory.[6]

The Jerome district has been made famous by the United Verde, which was originally a small gold and silver mine. The mine is opened on a single monstrous lens of sulphide ore, in slate, said to be at least 1,000 feet long, with an extreme width of 600 feet and having a dip of 72 degrees. The ore, owing to excess of sulphur, frequently catches fire from spontaneous combustion, and the mine has suffered much from fires. Owing to the precipitous nature of the ground and the location of the smelter and town of Jerome in a narrow gorge, with the smelter squarely on top of the mine, the ore is handled in a somewhat unique fashion. All ore is sent to the 500-foot level and thence trammed out through a 1,300-foot tunnel to the roast yard. When roasted, the ore is trammed back through the tunnel into the mine and hoisted through the shafts to the smelter.[1]

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[1] The Mineral Industry, 1895, Vol. IV, page 280.

[2] Transactions of the American Institute of Mining Engineers, Vol. XV, page 28.

[3] Ibid., page 42.

[4] Ibid., page 52.

[5] The Copper Handbook, Vol. III, page 225.

[6] Transactions of the American Institute of Mining Engineers, Vol. XV, page 60.

Besides these big camps, there are a number of others which would be notable in any other section of the country. The Ajo copper mines in Yuma county were among the first discovered.

Gold and silver.—Ores of gold and silver are widely distributed and the territory has a number of notable mines. The bonanza of the Silver King mine of Pinal county, discovered in 1874, is famous in the annals of the territory.[2] It is credited with the payment of $2,000,000 in dividends. The first locations in Tombstone, Cochise county, were made in 1878, and up to January 1, 1882, or in less than three years, the gold and silver output of the camp aggregated $7,359,200, of which over $3,000,000 had been disbursed in dividends.[3] Following the decline in the price of silver, and partly on account of difficulties experienced in draining the mines at Tombstone, they closed down and remained idle for a number of years. Active work was resumed in the Tombstone mining district in 1901-2, nearly all the important claims having been combined in the hands of one company.[4]

The Congress mines in Yavapai county were first opened in 1887, and were successfully operated until September, 1891, when they were closed, and the property remained idle until March, 1894. The mines have now been opened to a depth of 1,300 feet.[5]

The La Fortuna and the King of Arizona, of Yuma county, the Mammoth, of Pinal county, and the famous Vulture, of Maricopa county, which in years past was one of the great wealth producers of the Southwest, are but a few of the mines which have helped to make the reputation of Arizona.

Table 3, compiled from the annual reports of the Director of the Mint, shows the annual production and value of gold and silver in the territory of Arizona from 1889 to 1902, inclusive.

TABLE 3.—*Annual production and value of gold and silver: 1889 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	GOLD.[1]		SILVER.[1]	
	Fine ounces.	Value.	Fine ounces.	Coining value
1889	43,537	$900,000	1,500,000	$1,939,393
1890	48,375	1,000,000	1,000,000	1,292,929
1891	47,166	975,000	1,480,000	1,913,535
1892	51,761	1,070,000	1,161,900	1,502,255
1893	57,296	1,184,400	2,935,700	3,795,652
1894	96,313	1,990,966	1,539,153	1,990,101
1895	95,072	1,965,300	986,900	1,275,993
1896	125,978	2,604,200	1,913,000	2,473,373
1897	140,089	2,895,900	2,239,900	2,896,032
1898	119,249	2,465,100	2,246,800	2,904,954
1899	124,133	2,566,100	1,578,300	2,040,630
1900	202,856	4,193,400	2,895,500	[2]1,857,210
1901	197,515	4,083,000	2,812,400	[2]1,687,440
1902	198,933	4,112,300	3,043,100	[2]1,612,843

[1] Estimates of the Director of the Mint; value of refined product; silver at coining value. The values given in Table 1 are the values at the mine.

[2] Commercial value.

All other minerals.—Fluorspar was mined by two operators in Yuma county.

Lead ore was only produced by one mine operated as such, though the territory produces considerable lead as a by-product of its gold and silver ores.

The production of the territory classified under precious stones comprises, in the order of their values, turquoise, silicified wood, garnet, and peridot or chrysolite. Turquoises were found worn by the natives on the first entry of Marcos de Niza into the country in 1539, and prehistoric turquoise mines have been found at several points. Turquoise mining was almost unknown in the United States when the census of 1890 was taken, but it is now a regular industry. The present production of the territory comes from Mohave county. The agatized forest of Arizona, located in Apache county, not far from the town of Holbrook, affords a wealth of beautiful ornamental stone unequalled anywhere in the world. The logs and trunks of ancient trees, converted into agate and chalcedony of mingled shades, when cut and polished, give most exquisite effects of line and color. The yield reported in the last four years was $2,000 in 1898, $3,000 in 1899, $6,000 in 1900, and $7,000 in 1901.

Bohemian or pyrope garnets are found in several places in northern Arizona, and are sometimes called Arizona rubies. They are found generally around ant hills and scorpion holes, where they have been brought up and thrown out by the insects. The production of peridot or chrysolite is reported from Gila county, the specimens being found and brought in by Indians and others. The sandstone quarried was used chiefly for building stone, and the siliceous crystalline rock or granite quarried was all dressed for monumental work.

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[1] The Copper Handbook, Vol. III, page 530.

[2] The Mineral Industry, 1892, Vol. I, page 230.

[3] Transactions of the American Institute of Mining Engineers, Vol. X, page 334.

[4] Report of the territorial governor of Arizona, 1902, page 40.

[5] Ibid., 1903, page 123.

ARKANSAS.

Table 1 is a summary of the statistics of the productive mines and quarries in the state of Arkansas for 1902.

TABLE 1.—SUMMARY: 1902

	Total.	Coal, bituminous.	Limestones and dolomites.	Sandstones and quartzites.	Oilstones and whetstones.	Bauxite.	Siliceous crystalline rocks.	All other minerals.[1]
Number of mines or quarries	120	55	11	18	4	19	3	10
Number of operators	113	35	12	17	3	3	3	40
Salaried officials, clerks, etc.:								
Number	210	146	16	11	2	13	2	20
Salaries	$191,528	$148,113	$7,864	$5,806	$1,050	$10,875	$1,650	$16,170
Wage earners:								
Average number	2,964	2,574	119	111	23	50	10	77
Wages	$1,945,479	$1,780,061	$13,180	$72,170	$10,615	$14,808	$4,260	$40,189
Contract work	$820	$485				$335		
Miscellaneous expenses	$97,481	$82,949	$1,716	$1,830	$685	$4,175	$945	$5,181
Cost of supplies and materials	$244,870	$177,716	$32,579	$7,915	$1,625	$10,602	$650	$15,282
Value of product	$2,840,341	$2,589,214	$111,163	$85,967	$21,255	$13,920	$12,115	$51,757

[1] Includes operators as follows: Asphaltum and bituminous rock, 1; fuller's earth, 2; gold and silver, 1; manganese ore, 2; marble, 1; mineral pigments, crude, 1; phosphate rock, 1; precious stones, 30 (no mines); slate, 1.

The chief mineral product of the state is bituminous coal, though the amount is not large. The mining of bauxite is a new and growing industry. The oilstones and whetstones of the state, made from novaculite, have a high reputation.

In addition to the minerals referred to in Table 1, there are other important mineral products of which the state has been a producer, though they were not reported as being mined in commercial quantities in 1902, and still others that exist in such quantities as to justify the belief that with development or with improved transportation facilities they may add to the wealth of the state. Among these are: Antimony, which is said to occur in sufficient quantity in Sevier county to be of commercial value;[1] Portland cement, which was formerly manufactured at White Cliffs from the chalk deposits of southwest Arkansas, but which was not produced again until 1903, the remodeling of the plant being in progress in 1902; copper, which, in the form of carbonates and sulphates, has been found in many counties, notably in Searcy, and which was partially developed in 1885;[2] and iron ores, which are found at many points in the state, but not in extensive deposits.

The tardiness of the development of the zinc and lead deposits is due in part to the topography of the district, through which there have been no railroads until recently. The zinc bearing ore district of north Arkansas is a part of the Missouri district. The first active mining was in 1875, when a smelter was erected at Calamine, Sharp county, for the reduction of carbonate ores. The enterprise was not successful, and was abandoned. In 1880 a lead smelter was erected at Leadhill and was operated for a short time. The next development of note was in 1882, when a smelter was built and a town laid out at Boxley, Newton county. Operations were continued for a year, but the long wagon haul of 95 miles to the nearest railroad was too great a tax, and operations were suspended. The Morning Star mine, in Marion county, was discovered in 1884. The exhibitor of a monster piece of zinc carbonate, which weighed 12,750 pounds, from this mine, was awarded a gold medal at the Chicago Columbian Exposition. Smithsonite, calamine, and sphalerite ores are found, the last named being the most frequent in occurrence.[1] Argentiferous lead has been found in Pulaski, Sevier, Polk, Montgomery, and Howard counties.[2] Extensive beds of gypsum, often crystallized into selenite, are found in Pike, Bradley, and Howard counties;[2] kaolin is known to occur in Pike, Pulaski, Saline, and Ouachita counties;[4] lithographic stone of excellent quality occurs near Little Rock;[5] soapstone is found in Saline county, and has been quarried to some extent;[1] nickel occurs sparingly in Saline county; and oil and gas have been found in small quantities.

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[1] Bureau of Mines, Manufactures, and Agriculture of Arkansas, Sixth Biennial Report, page 162.

[2] Products and Resources of Arkansas, by D. McRae, 1885, page 11.

[3] Transactions of the American Institute of Mining Engineers, Vol. XXXI, page 396.

[4] Bureau of Mines, Manufactures, and Agriculture of Arkansas, Fourth Biennial Report, page 110.

[5] United States Geological Survey, "Mineral Resources of the United States," 1889–90, page 519.

Development work on deposits of asphaltum, gold and silver, and natural gas was reported by 3 operators. The total expense for development work was $5,800; of this amount $4,500, expended for work done by contract, furnished employment to 5 employees.

The following table shows the value of the products of those manufacturing industries of the state in 1900 that were based primarily upon minerals mined or quarried, and also the value of all products manufactured in Arkansas during that year:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$45,197,731
Based upon products of mines or quarries:		
Clay, glass, and stone products	$652,676	
Iron and steel and their products	456,814	
Metals and metal products, other than iron and steel	229,697	
Miscellaneous industries	876,703	
		2,215,890
All other		42,981,841

According to the foregoing table the value of the products of manufactures, based primarily upon minerals mined or quarried, amounted to $2,215,890, or 4.9 per cent of the total. The combined value of the products of mines and quarries in Arkansas in 1902 and manufactures in 1900 was $48,038,072, of which amount manufactures contributed 94.1 per cent and mines and quarries 5.9 per cent.

The average number of wage-earners in Arkansas engaged in manufacturing at the Twelfth Census was 26,501 and the wages paid amounted to $8,686,291. In 1902 the average number of wage-earners reported as engaged in mining was 2,944 and the wages paid amounted to $1,945,479. The two industries, therefore, gave employment to an average of 29,445 wage-earners during the year and paid $10,631,770 in wages. Manufactures alone gave employment to 90 per cent of the wage-earners, who received 81.7 per cent of the wages, while mines and quarries furnished employment to only 10 per cent of the wage-earners, who received 18.3 per cent of the wages.

Table 3 shows the value of the annual production of the principal minerals of the state from 1890 to 1902.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Limestones and dolomites.	Sandstones and quartzites.
1890	$514,555	$18,300	$25,074
1891	647,560	20,000	20,000
1892	666,230	18,000	18,000
1893	773,347	7,611	3,292
1894	631,988	38,228	2,365
1895	751,156	47,376	13,228
1896	755,577	30,708	1,100
1897	943,965	44,222	2,161
1898	1,238,778	54,373	24,825
1899	989,383	71,965	73,616
1900	1,653,618	71,407	104,923
1901	2,008,613	68,319	62,825
1902	2,539,214	113,163	85,917

Coal.—Practically no coal was mined prior to 1870, though it has been stated that some was taken out that year. Mining on a commercial scale can hardly be considered to antedate 1883, and from that time to 1887 the production was almost entirely confined to Johnson and Polk counties.[1] Most of the coal mined is of a very superior quality.

In 1902 coal production was reported from Sebastian, Johnson, Franklin, Pope, Scott, Logan, and Ouachita counties, over 68 per cent of the product being from Sebastian county alone.

Table 4 shows the annual production of bituminous coal in Arkansas from 1880 to 1902, inclusive, the figures being taken from the 1902 report of the United States Geological Survey.

TABLE 4.—*Annual production of coal, bituminous: 1880 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
Total	13,027,979	1891	542,379
		1892	535,558
1880	14,778	1893	574,763
1881	10,000	1894	512,626
1882	15,000	1895	598,322
1883	50,000	1896	675,374
1884	75,000	1897	856,190
1885	100,000	1898	1,205,479
1886	125,000	1899	843,554
1887	129,600	1900	1,447,945
1888	276,871	1901	1,816,136
1889	279,584	1902	1,943,932
1890	399,888		

Limestones and dolomites.—Limestone occurs quite generally throughout the state.[1] The production in 1902 was valued at $113,163, of which $82,853 was for stone made into lime and $22,510 for crushed stone used for roadmaking and railroad ballast. The balance was for riprap, building stone, curbing, and other uses. A marked increase is shown for 1902 in the value of limestone crushed for roadmaking.

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[1] Products and Resources of Arkansas, 1885, page 13.

[1] Arkansas Geological Survey, 1888, Vol. III, page 35.

Sandstones and quartzites.—The whole western side of the state is underlaid with a metamorphosed sandstone, and quarries have been opened in Carroll, Conway, Crawford, Independence, Johnson, Polk, Pope, Pulaski, Sebastian, Washington, and White counties.[1] Nearly one-half of the sandstone product was used for railroad ballast.

Oilstones and whetstones. In the Washita mountains west of Little Rock are large masses of novaculite from which the finest whetstones, known in the market as "Arkansas" and "Washita" stones, are made. The principal quarries are on Quarry or Whetstone mountain, near Hot Springs, Garland county, though the stone is also quarried in Saline county. The stones were first put on the market about 1840, in which year a quantity of rough stone was shipped to Europe and cut into whetstones. The next year a small quantity was cut up and manufactured into oilstones at St. Louis, and since that time the demand has continued steady.[2] The Arkansas stone is a true novaculite, an average analysis showing it to contain 99.5 per cent of silica.[3]

Bauxite.—The bauxite beds of Pulaski county were discovered by John C. Branner, state geologist, in 1887. At the time the rock was identified it was being extensively used for roadmaking. In some cases it contains so much iron that the beds have been prospected with a view to using the material as an iron ore. In other cases it contains so much silica and so little water that it is not distinguishable by analysis from ordinary kaolin, and the varieties grade insensibly into each other with no line of demarcation. It has been found in Arkansas only in Tertiary areas and in the vicinity of eruptive syenites. The beds vary greatly in thickness, the thickest found being 40 feet.[4]

The production of bauxite since 1899, when it was first reported, is shown in the following table:

TABLE 5.—*Annual production of bauxite: 1899 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.
1899	5,045
1900	3,445
1901	867
1902	1,615

All other minerals. Asphaltum was reported from Pike county in 1902 by one operator.

The only states producing fuller's earth in 1902 were Arkansas and Florida, the Arkansas product coming from Saline county. It was first discovered in the United States at Quincy, Fla., in 1893, where the greater part of the output of the United States has since been obtained.

The Arkansas granite, whether as paving stone or as building material, is unsurpassed and has been used to a considerable extent within and without the state.[5] The Pulaski county quarries, three in number, were the only ones reported as in operation in 1902, with a product valued at $12,115. This is a decline from former years, the product in 1900 having been valued at $62,500.

Manganese ore was mined in 1860, though the first report of output was made in 1868. The industry increased steadily, and a decade ago Arkansas was the principal manganese producing state. Its maximum output was in 1892, when the quantity reported was 6,708 tons. Since 1896 the output has declined rapidly. The entire production has come from the Batesville district, Independence county. There are vast deposits in Polk county and also in Izard county, but the high phosphorous contents, distance from railroad, and expense of mining have rendered much of it unmarketable.[6] The annual production of this mineral from 1881 to 1902, inclusive, is shown in the following table:

TABLE 6.—*Annual production of manganese ore: 1881 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1881	100	1892	6,708
1882	175	1893	2,020
1883	400	1894	1,934
1884	800	1895	2,991
1885	1,485	1896	3,421
1886	3,316	1897	3,240
1887	5,651	1898	2,062
1888	4,312	1899	356
1889	2,528	1900	145
1890	5,339	1901	91
1891	1,650	1902	82

Although Arkansas does not take high rank as a producer of the precious metals, yet gold and silver occur in many localities. Argentiferous galena is found in Pulaski, Sevier, Polk, Montgomery, and Howard counties.[7] Gold and silver mines in Polk county were prospected as early as 1860, and mining and development work was reported in 1902, with production from one mine in Polk county.

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[1] Bureau of Mines, Manufactures, and Agriculture of Arkansas, Fourth Biennial Report, page 117.

[2] The Mineral Industry, 1892, Vol. I, page 464.

[3] United States Geological Survey, "Mineral Resources of the United States," 1901, page 785.

[4] Transactions of the American Institute of Mining Engineers, Vol. XXX, page 347.

[5] Bureau of Mines, Manufactures, and Agriculture of Arkansas, Sixth Biennial Report, 1899–1900, page 167.

[6] Products and Resources of Arkansas, 1885, page 10.

[7] Ibid., page 11.

Marble is found in Independence, Izard, Marion, Searcy, Carroll, Saline, Newton, and Madison counties. It is of fine texture and various colors—pink, gray, white, and black.[1] The value of the product reported for the state in 1899 was $3,410. A small amount was also reported in 1901. The production reported for 1902 was from Carroll county.

There are extensive deposits of ocher found near Monticello, in Drew county, and in Clay county. There are also deposits in southern Arkansas and in other parts of the state. The production of crude mineral pigments reported for 1902 was from Clay county.

Phosphate beds occur—associated with what is known as the Sylamore sandstone and the Eureka shale—in the vicinity of Hickory valley, in the neighborhood of Cushman, Independence county, and at other points. The production reported for 1902 was from Independence county. Phosphate beds are also found in connection with the beds of the Ouachita uplift, and are known to occur in some of the Cretaceous beds of the state. The Cretaceous marls of the southwestern portion of the state are very like the Greensand marls of New Jersey, and are in all probability equally suitable for fertilizers.[2]

As precious stones, the quartz crystals of Hot Springs, Garland county, are famous, and their collection for sale to tourists has been an industry of many years' standing. Though not large enough for art purposes, they are beautiful as specimens. They are also found in Montgomery and Saline counties.

Roofing slate is found in Montgomery, Pike, Polk, Pulaski, Saline, and Sevier counties. The production reported for 1902 was from Montgomery county.

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[1] Products and Resources of Arkansas, 1885, page 12.

[2] Transactions of the American Institute of Mining Engineers, Vol. XXVI, page 580.

CALIFORNIA.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of California for 1902, which includes 2 operators in Alaska and 1 operator in Hawaii, to avoid disclosing operations of individual concerns.

TABLE 1.—SUMMARY: 1902.

	Total.	Gold and silver.	Petroleum.	Borax.	Copper.	Quicksilver.	Siliceous crystalline rocks.	Limestones and dolomites.	Sandstones and quartzites.	Asphaltum and bituminous rock.	All other minerals.[1]
Number of mines, quarries, and wells	4,037	1,020	2,757	4	7	36	64	17	[2]15	9	108
Number of operators	1,552	1,020	290	4	7	34	62	14	11	9	101
Salaried officials, clerks, etc.:											
Number	1,482	748	484	10	38	28	58	7	8	5	98
Salaries	$1,887,980	$1,010,846	$452,320	$14,778	$48,083	$131,278	$45,054	$9,400	$11,840	$8,280	$114,031
Wage-earners:											
Average number	12,961	7,989	1,112	141	496	1,096	920	291	303	52	534
Wages	$11,070,666	$7,101,033	$1,087,859	$108,525	$445,247	$780,926	$697,658	$163,130	$269,433	$20,031	$373,874
Contract work	$520,894	$47,056	$431,699	....	....	$22,929	....	$4,000	....	....	$15,200
Miscellaneous expenses	$1,783,790	$967,735	$571,158	$46,206	$15,367	$83,462	$69,282	$15,790	$14,756	$1,185	$58,897
Cost of supplies and materials	$5,673,755	$2,966,102	$1,479,825	$210,729	$211,163	$218,894	$115,429	$111,564	$80,967	$1,330	$248,029
Value of product	$28,870,406	$15,173,091	$4,873,617	$2,370,994	$1,599,663	$1,295,740	$1,137,679	[3]$521,093	$469,016	$101,853	$1,029,159

[1] Includes operators as follows: Cement, 2; chrome ore, 1; clay, 6; coal, bituminous, 10 (including 2 operators in Alaska); gypsum, 1; infusorial earth, tripoli, and pumice, 1; lithium ore, 2; magnesite, 1; manganese ore, 3; marble, 5; mica, 1 (10 mines); mineral pigments, crude, 2; natural gas 15 (29 wells); precious stones, 47 (31 mines); slate, 1; sulphur and pyrite, 2; and talc and soapstone, 1.

[2] Includes 1 operator in Hawaii.

[3] Exceeds United States Geological Survey report by $24,270, the value of limestone quarried for cement.

Gold is by far the most important mineral product of the state. The production of gold in 1902 exceeded in value that of all other minerals combined, being approximately $15,000,000, which was nearly one-fifth of the refined gold product reported for the United States (including Alaska). Petroleum was the mineral product next in value, borax was third, copper fourth, and quicksilver fifth.

A large number of minerals are known to exist in the state that were not mined in commercial quantities in 1902: Asbestos occurs in Tulare, Yolo, Butte, Placer, San Diego, Eldorado, and Mariposa counties in small quantities. Barytes has been observed in Calaveras, San Bernardino, Plumas, and Inyo counties. Buhrstones are known to exist in Inyo county. Corundum is found in drift at San Francisco pass, Los Angeles county, and feldspar is obtainable in Mariposa county. Iron ore exists in Placer, Sierra, Eldorado, Napa, Shasta, Amador, Inyo, Alameda, Del Norte, Butte, Alpine, and Nevada counties. Marl is found in various localities; nickel is obtainable in San Benito, Kern, Monterey, Tuolumne, and Mono counties; and cobalt occurs in Los Angeles county. Tin ore is known to exist in San Bernardino county, as well as lead, which also occurs in small deposits in Mono, Shasta, Amador, and other counties. Zinc is found in Tulare and San Mateo counties.[1] A deposit of fuller's earth was opened in 1898 near Bakersfield, in Kern county.[2]

In addition to the productive mines, quarries, and wells for which statistics are shown in Table 1, considerable development was done in 1902. The operators engaged in such work exclusively, reported an expenditure of $2,925,700 for salaries and wages, contract work, supplies and materials, and miscellaneous expenses. Of this amount, 81.3 per cent was expended upon gold and silver mines, and 17.5 per cent upon petroleum interests, the remainder being for limestones and dolomites, quicksilver, iron ore, siliceous crystalline rocks, borax, asphaltum, bituminous rock, and marble.

Table 2, showing the annual value of production of the principal minerals from 1890 to 1902, except copper ore, for which values can not be obtained, has been compiled from the United States Geological Survey, "Mineral Resources of the United States," and from reports of the Director of the Mint.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1887, pages 704 to 707.

[2] The Mineral Industry, 1898, Vol. VII, page 271.

TABLE 2.—VALUE OF PRODUCTION OF PRINCIPAL MINERALS: 1890 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Petroleum.	Borax.	Silver.[1]	Siliceous crystalline rocks.	Limestones and dolomites.	Sandstones and quartzites.	Coal, bituminous.	Natural gas.	Marble.	Manganese ore.
1890	$12,500,000	(2)	$480,152	$1,163,636	$1,329,018	$516,780	$175,768	$283,019	$33,000	$87,030	$3,176
1891	12,600,000	$401,264	640,000	969,697	1,300,000	400,000	100,000	204,902	30,000	100,000	3,890
1892	12,000,000	561,333	838,787	465,155	1,000,000	400,000	50,000	209,711	55,000	115,000	....
1893	12,080,000	608,092	593,292	607,806	531,322	288,626	26,314	167,555	62,000	10,000	2,000
1894	13,863,282	823,123	807,807	927,506	307,000	289,900	10,087	155,620	60,350	13,420	1,800
1895	14,928,000	849,082	595,900	845,180	348,806	322,211	11,933	175,778	55,000	22,000	5,400
1896	15,235,900	1,240,290	676,400	776,533	215,883	143,865	7,267	220,523	55,682	4,000	3,415
1897	14,618,300	1,714,102	1,080,000	613,566	167,518	308,925	1,035	265,236	50,000	48,690	2,788
1898	15,637,900	1,917,596	1,153,000	830,448	247,429	220,729	358,908	405,915	65,337	40,200	3,222
1899	15,197,800	2,508,751	1,139,882	1,065,762	471,665	287,295	261,103	130,695	86,891	6,500	855
1900	15,816,300	4,076,975	1,013,251	[3] 583,668	738,993	407,489	200,090	323,231	79,083	17,500	1,310
1901	16,891,400	4,971,540	1,012,118	[3] 555,360	1,184,675	645,455	301,028	391,106	67,602	6,642	3,610
1902[4]	16,792,100	4,873,617	2,370,994	[3] 477,424	1,137,679	521,093	462,328	254,350	120,648	92,298	10,176

[1] Estimates of the Director of the Mint, coining value.
[2] Value not reported—26,360 barrels.
[3] Commercial value.
[4] Census figures, except for gold and silver.

Of the principal minerals, bituminous coal and siliceous crystalline rocks are the only ones for which the value of production was smaller in 1902 than in 1890. The production of petroleum, which is rapidly replacing coal as a fuel, has very largely increased since 1890. Gold has increased from $12,500,000 in 1890 to $16,792,100 in 1902, but the value of the silver production has fluctuated. There has been a steady increase in the production of building stone since 1896, and in 1902 quarrying stood among the important industries of the state. The value of siliceous crystalline rocks in 1902 was $1,137,679, or more than one-half the value of all stone quarried. Limestone, sandstone, marble, and slate were also produced, ranking in value of product in the order named.

Gold and silver.—In California gold is found chiefly in a belt from 20 to 60 miles wide extending along the lower slopes of the Sierra Nevadas a distance of about 700 miles.[1]

The principal gold regions were in Amador, Butte, Calaveras, Eldorado, Fresno, Inyo, Mariposa, Mono, Nevada, Placer, Plumas, San Bernardino, San Diego, Shasta, Sierra, Siskiyou, Trinity, and Tuolumne counties.[2] California gold averages about 88 per cent fine (United States Mint). Many analyses, however, run up to 95 per cent or higher.[3] The gold occurs principally in auriferous gravels, high or deep gravels, and in gold bearing quartz veins.[4]

The occurrence of placer gold in California was discovered near the Colorado river in San Diego county as early as 1775.[5] On January 19, 1848, it was found near Coloma, Eldorado county, on Col. John Sutter's land, by James Wilson Marshall. The California legislature, in 1887, honored the memory of Marshall by appropriating $5,000 for a monument over his grave in Coloma.

The first deposit of California gold in a United States mint was made on December 8, 1848, and in 1850 an assay office was established at San Francisco. At the outset the precious metal was obtained by alluvial washings, but in 1852 quartz mining became prominent, and has now largely supplanted the placer operations.

In 1849, the first year after its discovery by Marshall, the production of gold in California was $5,000,000. Rapidly increasing year by year, the production in 1853 was nearly $60,000,000. Since then it has diminished until in 1866 the amount was but $27,000,000, and from 1881 to 1888 it varied from $18,200,000 to $12,750,000.[6] During the last ten years, up to 1902, the California gold production has been more steady, the average yearly value of product for this decade being $15,106,148.

Silver mining interests in the state are small as compared with gold. Deposits of silver chloride, occurring in fissure veins, small fractures, and pockets in liparite and tufaceous sandstone, are disseminated sparingly in the southwestern and other portions of the state.[7]

The production of silver in 1902 was reported in 27 counties, the principal of which are Shasta, Kern, San Bernardino, Calaveras, Mono, Fresno, and Inyo in the order named.[8]

The following table of annual production in fine ounces of gold and silver is compiled from the estimates of the Director of the Mint:

TABLE 3.—*Annual production of gold and silver: 1890 to 1902.*

YEAR.	Gold (fine ounces).	Silver (fine ounces).	YEAR.	Gold (fine ounces).	Silver (fine ounces).
1890	604,687	900,000	1897	707,160	474,400
1891	609,525	750,000	1898	756,153	642,300
1892	580,500	392,200	1899	735,194	824,300
1893	584,370	470,100	1900	765,109	941,400
1894	656,168	717,368	1901	817,121	925,600
1895	722,171	653,700	1902	812,319	900,800
1896	737,067	600,600			

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[1] Treatise on Ore Deposits, by J. A. Phillips and Henry Louis, page 741.
[2] Dana's Mineralogy, page 1095.
[3] Ibid., page 15.
[4] Ore Deposits of the United States, by James F. Kemp, pages 243 and 248.
[5] California State Mining Bureau, Fourth Annual Report, 1884, page 217.
[6] Descriptive Mineralogy, pages 18 and 19.
[7] Ore Deposits of the United States, page 242.
[8] Report of the Director of the Mint, 1902, page 79.

Petroleum. The area of petroleum bearing land has proved much greater than was at first supposed, and a good demand has stimulated prospecting in new territory. Oil bearing territory has even been found to extend under the ocean, and at Summerland, wells have been driven 200 feet from shore. The saving by the use of oil in the generation of steam for electric light and power plants and as a locomotive fuel, estimated at from 30 to 50 per cent, has caused it to replace coal, especially in sugar and other manufactories. Petroleum has also been quite extensively introduced as a household fuel. In the region of Los Angeles successful experiments with it have been made in improving the public highways. When sprinkled on a dry road the hot oil combines with the dust and forms a hard surface, durable and dustless.[1]

The production of petroleum has increased from a product of 303,220 barrels, valued at $356,048, in 1889, to 13,984,268 barrels, having a value of nearly $5,000,000, in 1902. This increase is best illustrated in the following table, compiled from reports of the United States Geological Survey, "Mineral Resources of the United States":

TABLE 4.—*Annual production of petroleum: 1891 to 1902.*

YEAR.	Barrels (42 gallons).	YEAR.	Barrels (42 gallons).	YEAR.	Barrels (42 gallons).
1891	323,600	1895	1,208,482	1899	2,642,095
1892	385,049	1896	1,252,777	1900	4,324,484
1893	470,179	1897	1,903,411	1901	8,786,330
1894	705,969	1898	2,257,207	1902	13,984,268

California oil is generally dark in color and heavy in specific gravity, differing from the Pennsylvania and Ohio product in that its base is asphaltum rather than paraffin. This quality makes it very valuable for the manufacture of varnishes, lubricants, etc. In some instances the oil is a semiviscid bitumen called maltha or brea. This substance, when refined as petroleum, reveals a considerable by-product of asphaltum, which has a limited market on the Pacific coast for paving purposes. Gasoline and a very satisfactory grade of lubricating oil are produced, but the illuminating product does not compare favorably with the eastern production.

Borax.—The Great Basin, lying between the Wasatch and the Sierra Nevada mountains, forms an alkaline plain which has been found to contain valuable borax deposits.[2] This plain is marked by desiccated lake beds in which certain salts derived from the rocks of their watersheds have concentrated. These dry lakes and alkali marshes may be found in all degrees of saturation, often covered with a crust beneath which is deep water or slime.

The mineral borax was discovered in Borax Lake, Lake county, by Dr. John A. Veatch, in 1856, but no attempt at working the deposit was made until 1864. The following table of borax production in the state, illustrates the growth, value, and locality of the industry up to 1890:[3]

TABLE 5.—ANNUAL PRODUCTION AND VALUE OF BORAX: 1864 TO 1889.

YEAR.	Production (pounds).	Value per pound (cents).	Value per ton (dollars).	Total value (dollars).	Remarks.
1864	24,304	39	780	9,478	Lake county, Borax Lake.
1865	251,092	37½	750	94,159	Lake county, Borax Lake.
1866	401,632	33	660	132,538	Lake county, Borax Lake.
1867	439,824	35½	710	156,137	Lake county, Borax Lake.
1868	64,513	33⅓	666	22,584	Lake county, Borax Lake.
1869	Nil.	35⅕	704	Nil.	None produced.
1870	Nil.	30¼	605	Nil.	None produced.
1871	Nil.	31¼	625	Nil.	None produced.
1872	280,000	32	640	89,600	Lake county, Lake Hachinhama.
1873	1,030,000	24½	490	255,110	San Bernardino county, 750,000 pounds; other counties, 280,000 pounds.
1874	1,829,771	14⅕	284	259,827	San Bernardino county, 1,729,891 pounds; other counties, 99,880 pounds.
1875	2,336,000	12⅜	247½	289,080	San Bernardino county, 2,147,000 pounds; other counties, 189,000 pounds.
1876	2,873,909	10½	201½	312,387	San Bernardino county, 2,752,000 pounds; other counties, 121,909 pounds.
1877	1,986,950	9¾	195	193,708	San Bernardino county, marshes.
1878	716,840	8⅛	161¼	66,257	San Bernardino county, marshes.
1879	727,146	9	180	65,443	San Bernardino county, marshes.
1880	1,218,000	12¼	245	149,205	San Bernardino county, marshes.
1881	1,380,000	13¾	275	189,750	San Bernardino county, marshes.
1882	1,464,000	13¾	275	201,300	San Bernardino and Inyo counties, marshes.
1883	1,800,000	14¾	295	265,500	San Bernardino and Inyo counties, marshes.
1884	2,038,000	9¾	195	198,705	San Bernardino and Inyo counties, marshes.
1885	1,884,000	8¼	165	155,430	San Bernardino and Inyo counties, marshes.
1886	2,570,000	6¾	135	173,475	San Bernardino and Inyo counties, marshes.
1887	2,030,000	5¾	115	116,725	Suspension of marsh bed workings.
1888	2,810,000	7	140	196,630	San Bernardino county, Calico district; Ventura county.
1889	1,930,000	7	140	135,100	San Bernardino county, Calico district; Ventura county.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1899, page 156.

[2] The Mineral Industry, Vol. I, 1892, page 43.

[3] California State Mining Bureau, Bulletin No. 24, May, 1902, "The Saline Deposits of California," by Gilbert E. Bailey, E. M., Ph. D., page 39.

Lake, San Bernardino, Inyo, and Ventura counties are the principal fields of borax deposits. In the Calico district, San Bernardino county, borate of lime is taken from a fissure vein and this is said to be the only place in the world where deep mining for borax is carried on.[1] These deposits, discovered in 1882, are very productive, and the workings have been extended to a considerable depth.

An interesting feature in connection with borax production is the phenomenal decrease in the value from 39 cents per pound to about 7 cents at the present time. The deposits of California are very extensive, and in some instances only an increased demand and a consequently higher price are necessary to make them profitable workings.

Copper ore.—Copper was not mined in California until 1860,[2] although the mineral was discovered in Los Angeles county as early as 1840. The period from 1860 to 1867 was one of considerable activity, and thousands of tons of copper ore were shipped to the Atlantic coast and Europe for reduction. Then occurred a depression in copper production in California due to a fall in prices, and for over fifteen years copper remained as one of the minor minerals of the state. In 1895 and 1896, when the rich deposits of Shasta county began to be worked with success, there occurred a general revival of copper mining in the entire state, and from 1897 copper production has been accounted one of the leading industries of California.

Copper deposits are said to occur in almost all of the counties of the state, but the principal regions of commercially important production are as follows:[3] Shasta county, the Coast Range, the Sierra Nevada, and the mineralized deserts of southeastern California. The Shasta county copper mines, in the north central part of the state, are the principal source of production, and the copper belt of the western slope of the Sierras, with its 400 miles of almost continuous copper deposits, occupies second place. The Coast Range copper deposits have been developed only in Del Norte county, but superficial prospecting displays the existence of the mineral throughout almost the entire length of the range. The copper deposits of southern California are scattered and do not form a regular chain or belt as do those of the three more important localities.

Quicksilver.—The American production of this mineral is principally in California. Cinnabar or sulphide of mercury was discovered there in 1845, and mining began at New Almaden in 1850.[4] In the Coast Range for 100 to 150 miles north and south of San Francisco occurrences of this ore are found to exist, most generally in irregular bodies distributed through metamorphic rocks of Cretaceous age. Quartz, calcite, and magnesite are the usual gangue minerals. In 1902 production was reported in nine counties in the state, amounting to $1,295,740 in value, of which $1,228,498 was the value of refined product in flasks of 76½ pounds each, and $67,242 the value of crude cinnabar not concentrated.

Siliceous crystalline rocks.—The quarrying of siliceous crystalline rocks in California began as early as 1853,[5] and in 1902 this industry ranked sixth in value of products among the mineral industries of the state.

Limestones and dolomites.—The total production of limestone in 1902 was somewhat less than that of the preceding year, due largely to the great decrease in its use as a paving material. Considerable interest centers in the use of limestone in the manufacture of cement, and in 1902 an amount valued at $24,250 was reported as used for this purpose.

Sandstones and quartzites.—The value of sandstone product reported in 1902 was $462,328, the largest production in any year during the period 1890 to 1902. During the last five years the quarrying of this stone has advanced from a minor industry to a position of importance in the state, and in 1902 California ranked fifth in sandstone production in the United States. Extensive quarrying was begun in 1898 to supply rough stone for breakwaters and jetties, and for several years was used principally for this purpose. In 1901 and 1902 its use for building purposes became of most importance.

Marble.—The value of production of marble in 1902 amounted to $92,298, or more than that of any other year since 1892. Of this amount $33,198 was reported as the value of the rough, unfinished marble for all purposes and $55,000 as that of marble used in interior decoration, the remainder being the value of the marble intended for monumental and ornamental work. The deposits are principally in the southern portion of the state, although occurrences are reported in the extreme north. California onyx is the most valuable of the marbles quarried, and is generally found in proximity to hot springs or associated with minerals known to have resulted from such waters.[6]

Slate.—A roofing slate, blue-black in color, with good cleavage, is produced in Eldorado and Mariposa counties, but statistics can not be given without disclosing the operations of individual establishments.

Asphaltum and bituminous rock.—The mineral asphaltum was known to exist in California long before it was commercially produced; there is a record of its use by the Indians and the Catholic fathers. The discovery of bituminous rock is said to have been in 1868 near Santa Cruz, and its use at that time, although local, was considered a success. The hard asphaltum occurs chiefly in Santa Barbara and Ventura counties; the liquid or maltha, in Santa Barbara and Kern, and the asphaltic sandstone and bituminous rock in Monterey, San Luis Obispo, and Santa Cruz counties. California asphaltic localities are thus in the vicinity of the Coast Range and south of San Francisco bay. A valuable and interesting deposit of the hard variety exists in Goleta, in Santa Barbara county. The asphaltum appears in a ledge washed by the Pacific ocean, and is exposed for a distance of several hundred yards. It occurs in pockets of from 1,500 to 3,000 tons, and is almost pure, containing only a small percentage of sand. Asphaltum is chiefly used as a rust proof coating for submarine and underground iron pipes. The commercial production of the mineral began in California in 1888, and flourished for two years, but the industry did not prove a financial success at the outset, and in 1890 no production was reported.[1] A resumption of activity in 1891 was more successful. Since that time there has been a general increase of production, and in 1902 California ranked first in this industry.

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[1] California State Mining Bureau, Bulletin No. 24, page 38.

[2] Ibid., Bulletin No. 23, "The Copper Resources of California," by L. E. Aubury, page 23.

[3] Ibid., Bulletin No. 23, page 10.

[4] Eleventh Census, Report on Mineral Industries, page 186.

[5] United States Geological Survey, "Mineral Resources of the United States," 1882, page 603.

[6] Ibid., Twentieth Annual Report, Part VI, page 288.

Coal.—Coal was discovered in the state during 1852, although no productive mining occurred until after 1860. In 1902 the production amounted to 84,984 short tons, principally lignite, which is a decrease of 66,095 short tons from the preceding year and less than one-half the production of 1900. The discovery and utilization of extensive oil fields is the principal cause of the marked decrease in coal production.

Natural gas.—Natural gas was known to exist in California as early as 1854, and the Court House well near Stockton, in San Joaquin county, was bored prior to 1858.[2] The principal localities in which gas was produced commercially during 1902 were Sacramento, San Joaquin, Santa Barbara, and Los Angeles counties. Important occurrences have been observed in Contra Costa, Fresno, Humboldt, Lake, Marin, Mendocino, Solano, Sonoma, Tehama, Tulare, and other counties. In some instances the gas is found in connection with petroleum, while in other cases it bubbles up in mineral springs or in artesian water flows.[3] The accumulation of very large high-pressure reservoirs of natural gas in this region has probably been prevented by the folded formation of the strata and the occurrence of earthquakes of greater or less severity. It is thought probable that larger quantities may be stored at greater depth than has yet been mined. The production of California natural gas in 1902 is valued at $120,648, in which is included gas to the value of $31,604, obtained from petroleum wells.

Manganese ore.—The first mining of manganese ore in California was at Corall Hollow in Alameda county in 1867.[4] Other deposits were known to exist, but for a number of years they were not considered to be of commercial importance. In 1902, however, several of these were opened up. The total product reported was 846 long tons, valued at $10,175, a very large increase when compared with the preceding years. The manganese ore is used principally in the manufacture of chlorine gas for working sulphureted gold ores.

The following are the minerals grouped in Table 1 under "all other minerals":

Cement.—The California production in 1902 was entirely of the Portland cement and was reported only in San Bernardino and Solano counties. Two establishments were in operation in 1902, and the production was much larger than that of previous years.

Chrome ore.—Chromic iron ore occurs in more than one-half the counties of California,[5] but the commercial production in 1902 was all reported by the Mt. Shasta chrome mine near Simms in Shasta county. This was the only active mine in the United States during 1902, and the product was sold principally in its crude state for furnace lining.

Clay.—Practically inexhaustible beds of clay, some of which is of very good quality, are found in California, accessible by railroad.[6] Extensive utilization of these vast deposits is somewhat discouraged by heavy eastern and European importations of clay manufactures at so low a rate as to curtail profitable local manufacture. The quantity produced in 1902 was somewhat less than that reported by the Geological Survey for the previous year, but an increase in the value of products, as compared with 1901, indicates that better prices prevail. In 1902 a total of 23,483 short tons, valued at $24,445, was produced; while in 1901 a production of 28,085 short tons, valued at $22,535, was reported.

Gypsum.—This mineral is commercially produced by one company in Los Angeles county. Of the product reported in 1902, 9.4 per cent was sold in crude form, 6.4 per cent was ground into land plaster, and 84.2 per cent was calcined into plaster of Paris.

Infusorial earth, tripoli, and pumice.—A deposit of infusorial earth of diatomaceous origin is found in Santa Barbara, and a considerable production was reported in 1902, which was all sold in the crude form.

Lithium ore.—Lepidolite and amblygonite are the principal lithium minerals[7] obtained. They are used chiefly in the manufacture of lithium effervescent tablets and lithium carbonate for the preparation of mineral waters for medicinal purposes. The California product, obtained only in San Diego county, is nearly all shipped to New York for treatment, and constitutes a very large portion of the United States production.

Magnesite.—Although this mineral occurs in several states it is mined commercially only in California.[8] There is an abundance of the ore in the state, but distance from large manufacturing centers prevents shipment under present conditions. The production during 1902 was all mined in Tulare county, and is reported by one company.

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[1] United States Geological Survey, Twentieth Annual Report, Part VI, pages 254 and 255.

[2] Eleventh Census, Report of Mineral Industries, page 506.

[3] United States Geological Survey, Nineteenth Annual Report, Part VI, page 179.

[4] Eleventh Census, Report on Mineral Industries, page 291.

[5] Eleventh Census, Report on Mineral Industries, page 333.

[6] Ninth Annual Report of the State Mineralogist, page 297.

[7] United States Geological Survey, "Mineral Resources of the United States," 1902, page 260.

[8] Ibid., Sixteenth Annual Report, 1894-95, Part IV, page 515.

Mica.—The operations during 1902 were mostly development work, although a small production was reported from Ventura county. The product was entirely scrap mica, which was ground for lubricants and other purposes.

Mineral pigments, crude.—Yellow ocher is produced in Calaveras county, near Valley Springs, and in Stanislaus county. There were but two companies operating in California in 1902.

Precious stones.—The principal precious stones reported in California are turquoise and tourmaline, with chrysoprase and gold quartz in minor quantities, the total production in 1902 being valued at $65,000. Diamonds have been found at irregular intervals,[1] principally by placer gold miners, but every discovery thus far has been purely accidental, and none was reported during the census year. Quartz crystals have been found near Placerville, and chiastolite macle, or cross-stone, has been obtained in Madera county, but no product was reported for 1902.

Sulphur and pyrite.—A considerable production of pyrite was reported from Alameda county. The ore averages from 49 to 50 per cent sulphur and is chiefly used for the manufacture of sulphuric acid.

Talc and soapstone.—Serpentines and soapstone occur in Los Angeles county, on Santa Catalina Island, and were mined in considerable quantity in 1902.

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[1] Eleventh Census, Report on Mineral Industries, page 669.

COLORADO.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Colorado for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Gold and silver	Coal, bituminous.	Iron ore.	Petroleum.	Sandstones and quartzites.	Limestones and dolomites.	Copper ore.	Clay.	Siliceous crystalline rocks.	Uranium and vanadium.	Lead and zinc ore.	All other minerals.[1]
Number of mines, quarries, and wells	1,147	772	126	33	111	51	11	18	4	10	3	3	5
Number of operators	1,011	772	80	20	12	47	9	18	4	10	3	3	33
Salaried officials, clerks, etc.:													
Number	1,898	1,148	611	33	23	33	6	25	3	7	2	3	4
Salaries	$2,663,333	$1,687,518	$818,445	$42,577	$43,055	$28,704	$6,566	$17,338	$2,460	$6,345	$3,500	$2,025	$4,800
Wage-earners:													
Average number	20,519	11,200	7,955	418	147	343	188	115	50	46	19	5	33
Wages	$18,874,836	$11,726,123	$6,006,183	$417,162	$138,436	$237,905	$127,747	$108,981	$32,642	$34,082	$17,040	$5,475	$23,060
Contract work	$393,985	$360,707	$14,413		$9,650			$955	$7,450			$800	
Miscellaneous expenses	$3,032,544	$2,156,217	$681,494	$114,510	$40,163	$12,089	$5,886	$4,608	$7,637	$2,930	$490	$490	$6,000
Cost of supplies and materials	$7,006,846	$5,603,452	$1,059,831	$137,450	$68,708	$19,196	$21,440	$38,221	$5,608	$1,720	$3,010	$3,000	$45,210
Value of product	$40,683,296	$29,655,974	$8,397,812	$1,084,424	$184,683	$366,161	$203,700	$71,411	$67,131	$66,023	$48,125	$22,398	$185,141

[1] Includes operators as follows: Cement, 1; gypsum, 1; natural gas, 3; precious stones, 25 (no mines); tungsten, 3.

The state is notable for its range of mineral wealth. In the production of both gold and silver, it is first among the states and territories producing the precious metals in 1902, over 36 per cent of the refined gold product and over 27 per cent of the silver product reported for the United States (including Alaska) being contributed by this one state. In coal it ranked eighth among the 29 coal producing states, tenth among the 25 states producing iron ore, and ninth among the 18 petroleum producing states. Moreover, it produced all of the uranium and vanadium and almost all of the tungsten reported.

In addition to the minerals referred to in Table 1, there are found within the state—although these minerals were not produced in commercial quantities in 1902—antimony, arsenic, cobalt, corundum, flint and feldspar, fluorspar, graphite, infusorial earth, marble, mica, molybdenum, nickel, pyrites, quicksilver, serpentine, soapstone, tellurium, and tin.

Although no bismuth production was reported for 1902, the state supplied the entire United States output in 1901, amounting to 318.6 short tons, valued at $25,488. Of this, 253.6 tons came from Lake county and 65 tons from Ouray county. The bismuth contents varied from 4 to 12 per cent, and the ores also carried gold and silver values.[1]

The 964 operators reporting development work, distributed through the industries of gold and silver, bituminous coal, petroleum, asphaltum, iron ore, and manganese ore, gave employment during the year to 456 salaried officials, clerks, etc., who received $437,788 in salaries, and to 2,337 wage-earners, who were paid $2,340,058 in wages. They also paid $582,948 for work done by contract, which furnished employment to 911 employees. The miscellaneous expenses amounted to $213,816, and the cost of supplies and materials to $1,030,605.

The relative importance of the manufacturing industries closely allied to or based on the mining industry, using as their raw material the product of the mine or quarry, is shown in Table 2.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product	
All manufactures		$102,830,137
Based upon products of mines or quarries:		
Chemicals and allied products	$1,306,845	
Clay, glass, and stone products	1,976,711	
Iron and steel and their products	10,365,780	
Metals and metal products, other than iron and steel	46,217,288	
Miscellaneous industries	6,046,255	
		65,912,879
All other		36,917,258

According to the above table, the value of the products of manufactures based primarily upon minerals mined and quarried amounted to $65,912,879, or 64.1 per cent of the total. The combined value of the product of mines and quarries in Colorado in 1902 and of manufactures in 1900 was $143,433,423, of which manufactures constituted 71.7 per cent and the products of mines and quarries 28.3 per cent.

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[1] Unites States Geological Survey, "Mineral Resources of the United States," 1901, page 259.

The average number of wage-earners in Colorado engaged in manufacturing, as reported at the Twelfth Census, was 24,725 and the wages paid them amounted to $15,146,667. In 1902 the average number of wage-earners reported as engaged in mining was 20,519 and the wages paid them amounted to $18,874,836. The two industries together, therefore, gave employment to an average of 45,244 wage-earners, and paid $34,021,503 in wages. Manufactures gave employment to 54.6 per cent of the wage-earners and paid 44.5 per cent of the wages, while mines and quarries furnished employment to 45.4 per cent of the wage-earners and paid 55.5 per cent of the wages.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the production of the principal minerals of the state, except copper ore for which values can not be obtained, from 1890 to 1902.

TABLE 3.—VALUE OF ANNUAL PRODUCTION OF PRINCIPAL MINERALS: 1890 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Silver.[1]	Coal, bituminous.	Iron ore.	Petroleum.	Sandstones and quartzites.	Limestones and dolomites.	Siliceous crystalline rocks.
1890	$4,150,000	$24,307,070	$4,344,196	(2)	$290,240	$1,224,098	$138,691	$311,673
1891	4,600,000	27,359,384	4,800,000	(2)	369,000	750,000	90,000	300,000
1892	5,300,000	34,433,681	5,685,112	$587,903	692,160	750,000	100,000	100,000
1893	7,527,000	33,407,483	5,104,602	514,812	497,581	125,077	60,000	77,182
1894	10,616,463	30,704,875	3,516,340	676,141	303,672	69,105	132,170	49,302
1895	13,305,100	30,252,600	3,675,185	702,520	336,010	82,237	116,335	35,000
1896	14,911,000	29,185,293	3,606,642	524,915	318,077	58,899	65,063	86,517
1897	19,104,200	27,974,335	3,947,186	485,009	332,132	50,847	79,256	44,291
1898	23,195,300	29,499,958	4,686,081	553,406	367,147	89,637	109,310	25,928
1899	25,982,800	29,301,527	5,363,667	749,734	404,110	129,815	96,456	78,261
1900	28,829,400	[3]12,700,018	5,858,036	1,510,831	323,431	119,658	160,597	143,054
1901	27,693,500	[3]11,002,680	6,441,891	1,284,255	461,031	237,331	245,709	138,996
1902[4]	28,468,700	[3]8,808,290	8,397,812	1,064,421	184,680	866,161	203,700	66,023

[1] Estimates of the Director of the Mint for refined product—silver at coining values, the value in Table 1 is the value at the mine.
[2] Value not reported.
[3] Commercial value.
[4] Census figures, except for gold and silver.

Gold and silver.—Gold was discovered in 1852 near the mouth of Clear creek within the present boundaries of Arapahoe county by a Cherokee cattle trader, and in 1858 an expedition was organized to search for gold in the state. The passing of this expedition through Missouri and Kansas caused others to join the movement, and the reports of the discoveries that were carried back to "the states" spread like wildfire. The next spring and summer witnessed the great stampede for Pikes Peak and the Rockies. The first gold bearing lode was discovered May 6, 1859, in what is known as the Gregory mining district in Gilpin county.[1]

The mining growth of the state is best reviewed by considering the development of the more important of the gold and silver producing counties.

Boulder county is one of the pioneer counties of the state and has been the scene of active mining since its first settlement. The mining area is divided by somewhat indefinite boundaries into six mining districts, locally known as Grand Island (Caribou-Eldora), Sugar Loaf, Magnolia, Gold Hill, Central (Jamestown), and Ward. The county records show that the lode claim, placer claim, tunnel site, and mill site locations filed for record aggregate nearly 15,000. Of these, United States patents have been issued for about 1,000. Many of the location certificates filed are, of course, relocations of the same property. The ores are varied, including the common forms of iron and copper sulphide, chalcopyrite, and marcasite, while the complex silver and copper sulphides are not uncommon. The so-called telluride belt, extending from Magnolia to Ballarat, produces high-grade gold and silver telluride ores and is noted for its fine minerals.[2]

Chaffee county was formerly a part of Lake county, and the discovery of gold in the placer mines near Granite in the early days was almost coincident with the discovery of the placers of Clear Creek and Boulder counties. Great activity prevailed until 1862, when there was an exodus to other and supposedly better sections. The mining districts again became active during 1874–76. Since 1897 interest in the mines of this county has been gradually increasing, and the year 1902 marks not only more active operations but also a great increase in the list of new operators. The old placer mines near Granite have been operated with improved appliances. The leading districts are La Plata, Hope, and Red Mountain, in the northwestern part of the county; Dewey and Granite, in the northeastern; the Park Range region; the country adjacent to Turret, Whitehorn, Manoa, and Calumet; the Cleora district; and the Chalk Creek district. The county records show the filing of nearly 14,000 locations for placer and lode claims and mill sites and tunnel sites, and the issue of nearly 1,000 United States patents.[3]

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[1] Harper's Encyclopedia, Vol. 2, page 246.

[2] Report of the State Bureau of Mines, Colorado, 1901–2, pages 19 to 21.

[3] Ibid., pages 27 to 32.

Clear Creek county embraces the location of the first remunerative placer mine located in Colorado, discovered in 1859 near the mouth of Chicago creek. The county records show nearly 23,000 lode and placer claims and mill and tunnel sites, and the issue of about 1,300 United States patents. The county contains some of the most famous mining camps in the state—Idaho Springs, Silver Plume, Georgetown, and Empire. The underground development of some of the older mines has become quite extensive—the Dives-Pelicon, Bismarck, and 7-30 group near Silver Plume aggregating some 20 miles of underground workings.[1]

The mining history of Eagle county began with the year 1879, following the Leadville boom. The ores of the two regions are of a similar character. The county is rugged and contains within its confines the famous Mount of the Holy Cross. The mines are generally opened up by tunnels or inclines.[2]

Gilpin county, although the smallest in area, has always been one of the most important mining sections in the state. Beginning with 1859, mining has been continuous and its production large. Placer mining has been prosecuted each year since 1859-60, and the explorations of its lode mines have been carried even as deep as 2,200 feet. Central City, Black Hawk, Nevadaville, Eureka, and Gregory are some of its famous mining districts, the latter embracing Black Hawk and the Bates and Bobtail hills.[3]

Gunnison, one of the western slope counties, was the scene of a "rush" during 1880, second to none in the history of the state. Mining camps sprang up at numerous points, followed by smelting plants and mills.[4]

The first valid mineral locations were made in Hinsdale county in 1874. The ores of the district are, however, as a whole, of low grade and require concentration prior to shipment. The mineral resources are great and of a character to insure permanency of output.[5]

Lake county has been made famous by Leadville. Auriferous sand and gravel was the quest of the first gold seekers, and in 1860 a party of Gilpin county gold hunters crossed the range and discovered rich placers of California gold which produced several millions and were active for many years. It was not until the seventies that it was discovered that the heavy bowlders and dirt which had bothered the gulch miners were argentiferous lead carbonates. Leadville was settled in August, 1877, and at once became a heavy producer. The production of Lake county in 1902 was 47,357 fine ounces of gold, valued at $903,602, and 3,265,597 fine ounces of silver, valued at $1,659,210.

The history of Ouray county began practically with the year 1875, and was made famous at an early day by the rich copper-silver ores of the Yankee Girl, Guston, and other mines of the Red Mountain district. Later the publicity given to the Camp Bird mine of the Mt. Sneffles district added greatly to the reputation of the county and swelled the gold product of the state. This mine was discovered early in the eighties and was worked for a number of years to a limited extent on a pay streak near the foot wall, the operators being in ignorance of the immense values contained in an ore band near the hanging wall.

Pitkin, another of the leading mining counties, was traversed casually by early prospectors who made no discoveries of importance. But after experience gained at Leadville important discoveries were made in 1879 at Aspen, the most famous camp of the county. Owing to the inaccessibility to market, production was restricted until the Denver and Rio Grande Railroad reached Aspen in 1887.[6]

The veins of San Miguel county, which was established by legislative enactment in 1883, are similar to those of Ouray and San Juan counties. Gold and silver are generally associated with iron pyrite, chalcopyrite, lead sulphide, and zinc blende. Before the advent of railroad transportation in 1890, ores carrying high values were the only ones mined to any extent. At the present time the main production from this section is derived from ores having a gross value of from $8 to $20 per ton. Mining operations are conducted on a large scale, the largest producers being equipped with expensive milling plants.[7]

San Juan county is noted for the number and continuity of its fissure veins. Mining practically began in 1870, and was prosecuted with varying success until the railroad reached Silverton in 1882. It has since developed into one of the most important mining sections of the state. Nearly one-fifth of the area of the county is held under mineral locations.

Summit county was one of the original subdivisions out of which has been carved a number of counties. Its mining history begins with 1859. The placer beds on the Blue river and its tributaries are credited with a production of many million dollars' worth of gold. Ten Mile mining district is also in this county. The ore deposits occur both as fissure and as "contact" veins, the predominating value being silver, though nearly all the lode veins carry a small percentage of gold. The gold product, on the whole, exceeds the silver on account of the product of the placer mines.[8]

The Cripple Creek district, located in Teller county, is at present the most productive gold district in the United States, although the discovery of gold in that district was not made until February, 1891. The gold product of Teller county in 1902 was 699,487 fine ounces, valued at $13,996,421. This was 52.6 per cent of the gold product of the state, and 18.9 per cent of the entire gold product of the country. The numerous mines are, with a few exceptions, developed by shafts, a number of which have passed the 1,000-foot mark.

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[1] Report of the State Bureau of Mines, Colorado, 1901-2, pages 36 and 37.

[2] Ibid., pages 57 to 61.

[3] Ibid., page 72 ff.

[4] Ibid., page 81

[5] Ibid., pages 92 to 97.

[6] Report of the State Bureau of Mines, Colorado, 1901-2, page 151.

[7] Ibid., pages 183 to 195.

[8] Ibid., pages 213 to 220.

Coal.—The lignite beds of the upper Missouri were noticed by Lewis and Clark, 1803-4; those of the Laramie plains by Fremont, 1842; and those of the Raton mountain region by General Emory as early as 1848. Coal was first developed at Boulder in 1860,[1] although the first production from the state was not reported until 1864. The Marshall mines of Boulder county had already been worked for some years, and the coal was bringing from $12 to $15 a ton in Denver.[2] In 1872 production was reported from Weld county, and in 1873 from Las Animas and Fremont counties.

Coal is now reported from 18 counties, the heaviest producers being Las Animas, Huerfano, Boulder, Fremont, Pitkin, and Gunnison counties, in the order named. These counties produced over 90 per cent of the coal reported for 1902.

The state is rich in the variety of its coals, which range from lignite to anthracite. Lignites are mined in Arapahoe, Boulder, Douglas, El Paso, Jefferson, Larimer, and Weld counties; bituminous in Garfield, Gunnison, Huerfano, Las Animas, La Plata, Mesa, and Pitkin counties; semibituminous in Fremont, Garfield, Gunnison, and La Plata counties; and anthracite in Gunnison county.[3] For statistical purposes the Bureau of the Census and the Geological Survey have classed the entire production of the state as bituminous.

Table 4, compiled from the reports of the United States Geological Survey, shows the production of coal in Colorado from 1864 to 1902, inclusive.

TABLE 4.—*Annual production of coal, bituminous: 1864 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1864	500	1884	1,130,024
1865	1,200	1885	1,356,062
1866	6,400	1886	1,368,338
1867	17,000	1887	1,791,735
1868	10,500	1888	2,185,477
1869	8,000	1889	2,597,181
1870	13,500	1890	3,077,003
1871	15,600	1891	3,512,632
1872	68,540	1892	3,510,830
1873	69,977	1893	4,102,389
1874	77,372	1894	2,831,409
1875	98,838	1895	3,082,982
1876	117,666	1896	3,112,400
1877	160,000	1897	3,361,703
1878	200,630	1898	4,076,347
1879	322,732	1899	4,776,224
1880	437,005	1900	5,244,364
1881	706,744	1901	5,700,015
1882	1,061,479	1902	7,401,343
1883	1,229,593		

Iron ore.—The first iron manufacturing enterprise was that of a small charcoal furnace at Langford, Boulder county, which was put in blast in 1864, with the object of supplying pig iron for foundry purposes. It went out of blast in 1865 and was soon afterwards abandoned. The ore was obtained in the neighborhood. The owners of this furnace built a foundry at Denver in 1861, but removed it to Black Hawk in Gilpin county in 1862. March 1, 1878, a rolling mill to reroll rails was put in operation at Pueblo, but it was removed to Denver during the year. On September 7, 1881, the first large coke furnace was put in blast at Pueblo, and the Bessemer steel works, of the same place, were finished in 1882.[4]

The iron ore production of the state in 1902 amounted to 306,572 long tons, valued at $1,084,424, an average of $3.54 a ton. This high average value of Colorado iron ore is due to its silver contents, and to its availability for use as a fluxing medium when mixed with other gold and silver ores in the smelter.

In the production of iron ore is included 13,275 tons of manganiferous iron ore, valued at $52,371, which was used in the manufacture of spiegeleisen at the steel works.

The following table, compiled from the reports of the United States Geological Survey, shows the production of iron ore in Colorado from 1889 to 1902:

TABLE 5.—*Annual production of iron ore: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1889	109,136	1896	216,819
1890	114,275	1897	187,314
1891	110,942	1898	318,180
1892	141,769	1899	307,557
1893	171,670	1900	467,084
1894	250,199	1901	401,097
1895	240,937	1902	306,572

Petroleum.—The first indications of petroleum were found about 1859 at Oil Springs in Fremont county, some 10 miles northwest of Florence. In March, 1862, crude oil was collected from the springs by sinking shallow wells, and between 1862 and 1865 the oil collected was refined and most of it was transported by team to Pueblo, Denver, and Santa Fe. For some of this refined oil as high as $5 a gallon was realized. The advent of railroads rendered the industry unremunerative and it was abandoned. In 1881, while drilling a well for water near the coal mines at the town of Coal Creek, the drillers discovered oil at a depth of 1,260 feet. The discovery was followed up with varying success, no production being reported until 1887.[5]

The development of the Boulder field was begun near the close of 1901, and there was great activity throughout the state in 1902. The superior quality of the petroleum developed at Boulder led to a large amount of drilling in northern Colorado. Operations were active at Boulder, Fort Collins, and in the Florence field and to a lesser extent in Pueblo, Archuleta, Rio

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[1] History of Nevada, Colorado, and Wyoming, by Hubert H. Bancroft, page 578, note 9.

[2] F. V. Hayden, Silliman's Journal, March, 1868.

[3] Biennial Report of the Inspector of Coal Mines, Colorado, 1899-1900, page 89 ff.

[4] Iron in All Ages, by James M. Swank, pages 343 and 344.

[5] Eleventh Census, Vol. XIV, page 482.

Blanco, and Routt counties and at Raton. The production of the Boulder pool in 1902 amounted to 11,800 barrels. It will be seen from Table 6 that the largest production, 824,000 barrels, was made in 1892, the average production since being but a little more than half that amount.

Table 6, compiled from the reports of the United States Geological Survey, shows the annual production of crude oil in Colorado from 1887 to 1902, inclusive.

TABLE 6.—*Annual production of petroleum: 1887 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Barrels.	YEAR	Barrels
Total	6,852,926	1894	515,746
		1895	438,232
1887	76,295	1896	361,450
1888	297,612	1897	384,934
1889	316,476	1898	444,383
1890	368,842	1899	390,278
1891	665,482	1900	317,385
1892	824,000	1901	460,520
1893	594,390	1902	396,901

Sandstones and quartzites.—The state contains a variety of sandstones, which are now quite generally quarried. Reports for 1902 showed 51 quarries and 47 operators, distributed among Boulder, Delta, Douglas, Eagle, El Paso, Fremont, La Plata, Larimer, Las Animas, and Pueblo counties, the largest number being in Boulder county. The Red Beds yield building stones of a great variety of shades, texture, and strength. Numerous quarries, which furnish fine yellow and blue-gray stone, have been opened in Boulder county on the Cretaceous sandstones. In Fremont county there occurs a fine grayish or buff stone of Laramie age that closely resembles the Subcarboniferous stone of Berea, Ohio.[1]

Limestones and dolomites.—Limestone is quarried in 8 counties—Chaffee, El Paso, Fremont, Gunnison, Jefferson, La Plata, Pitkin, and Pueblo. A little more than three-fourths of the product is used for flux.

Copper.—The production of copper ore from mines operated for that mineral is comparatively small, the value of the product so reported being but $71,411 from 18 mines. There is, however, a large copper production by the smelters of the state, who purchase argentiferous copper ores and mattes in the open market.

Clay.—The clay sold by the miner, which is the only clay reported, is but a small part of the actual clay product of the state. It should be borne in mind that the clay which is manufactured by the producers was not taken into account in this inquiry. Clay valued at $67,434 was mined and sold as such by four establishments. The total value of brick and tile, and pottery, terra cotta, and fire clay products produced in the state in 1899 was $1,071,388. In 1900 the value of the same class of clay products was $1,200,519, and in 1901 it was $1,594,867, the state then ranking fourteenth in the value of these products. In 1902 the state ranked twelfth, though the value of the clay products had increased to $2,200,983.

Siliceous crystalline rocks.—Ten quarries of siliceous crystalline rocks were in operation in the counties of Boulder, Chaffee, Clear Creek, Fremont, Jefferson, Gunnison, and Larimer, and produced stone valued at $66,023—chiefly building stone. Fine gray granite occurs at Georgetown and Lawson, in Clear Creek county, and there are inexhaustible quantities of good material all through the mountains.[2]

Uranium and vanadium.—The only production of these metals in the United States was from three mines in Colorado—one each in Gilpin, Montrose, and San Miguel counties. The output amounted to 3,810 short tons of ore, valued at $48,125, the bulk of this production being contributed by the San Miguel county mine. The production of uranium in 1900 was reported as 153 short tons, carrying from 5 to 16 per cent of uranium oxide, and in 1901 it was 375 short tons.[3]

Lead and zinc.—The lead and zinc production in Colorado is practically all from the smelting of ores carrying precious metals. The nonargentiferous lead and zinc ore mined in 1902 amounted to only 1,636 short tons, of which 1,536 tons were zinc.

All other minerals.—The first production of Portland cement was reported for 1901 from one establishment in Fremont county. In 1902 two establishments were in operation; one of these quarried its raw material. As the other manufactured from purchased material, the statistics of its operation are not included in the report on mines and quarries.

Gypsum has been quarried to a small extent for a number of years, the bulk of the product being calcined into plaster of Paris. Numerous deposits of gypsum are known to exist in all the Rocky mountain territory. At the census of 1890 the beds that had so far been worked were in the neighborhood of Big Thompson, Larimer county, and Colorado Springs, El Paso county. Production of plaster of Paris was reported from the mill at Colorado Springs as early as 1879, when the output was 150 short tons. The production of 1902 was from one establishment near Loveland, Larimer county.

The natural gas produced in Colorado comes from the oil wells. In 1902 the output was valued at $1,900.

The precious stones reported for 1902 were smoky quartz and amazon stone. Smoky quartz occurs at and near Pikes Peak, where it is abundant in a coarse granite, associated with amazon stones—crystals of green feldspar—for which that locality is famous. It is also found at Mt. Antero, Chaffee county. One of the finest faceted stones in the world, measuring 3½ inches in length, exhibited at the Columbian Exposition, was from Mt. Antero. Aquamarines have also been found at Mt. Antero within recent years. Topazes have been found at Cheyenne mountain, Pikes Peak, and at Nathrop. Some fine rock crystal has been furnished by the state, especially from Mt. Antero. Amethyst has been reported from Cripple Creek and from localities in Park and Mineral counties. Turquoise is reported from the southern part of the state, and prosopite, a fluoride of alumina, occurs at Pikes Peak.

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[1] Stones for Building and Decoration, by George P. Merrill, pages 132 to 135.

[2] Stones for Building and Decoration, page 53.

[3] United States Geological Survey, "Mineral Resources of the United States," 1900, page 265, and 1901, page 270.

Tungsten ores, wolframite, and hubnerite have been found in quantity in San Juan, Boulder, Gilpin, Ouray, and Lake counties. In 1902 production was reported from three mines—two in Boulder county and one in San Juan. The only other producer in the United States was one mine in Connecticut. It is only within a few years that it has been known to exist in commercial quantities in Colorado. Shipments were reported in 1900 of 45½ short tons, carrying from 60 to 71 per cent of titanic acid.[1]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1900, page 258.

CONNECTICUT.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Connecticut for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Siliceous crystalline rocks.	Limestones and dolomites.	Sandstones and quartzites.	Feldspar.	Crystalline quartz.	Flint.	All other minerals.[1]
Number of mines or quarries	90	49	12	7	6	4	4	8
Number of operators	78	44	7	7	6	3	4	7
Salaried officials, clerks, etc.:								
Number	151	87	18	15	8	8	2	13
Salaries	$132,096	$75,662	$18,880	$13,554	$5,346	$6,000	$1,200	$11,454
Wage-earners:								
Average number	1,497	943	135	142	71	18	10	178
Wages	$928,772	$635,334	$66,765	$73,939	$53,672	$8,792	$4,835	$85,435
Miscellaneous expenses	$59,918	$31,869	$8,028	$6,881	$4,564	$1,400	$675	$5,161
Cost of supplies and materials	$236,075	$118,231	$64,346	$14,668	$10,677	$700	$1,965	$25,488
Value of product	$1,425,959	$812,141	$205,371	$128,579	$73,764	$32,075	$11,575	$162,454

[1] Includes operators as follows: Asbestos, 1; clay, 1; garnet, 2; iron ore, 1 (2 mines); marble, 1; and tungsten, 1.

The state ranked fortieth in mining in 1902 according to the value of its product. Its principal mineral products were nonmetallic. Connecticut, in early years, was a pioneer in mining enterprise, but later its mines, never very productive, have fallen largely into disuse. The first of the early colonists to turn his attention in the direction of mining seems to have been Governor Winthrop, who, from 1650 to 1660, engaged at intervals in examining the metalliferous indications of the Connecticut valley, in the vicinity of Haddam and Middletown. There is no reason to suppose that any actual mining was ever executed by him.[1]

The copper mines of Simsbury were discovered about 1705,[2] ruined a number of successive proprietors, and were finally made into a state prison, long since abandoned. In 1709 the first mining company organized in the United States was chartered to operate these mines. The material for the "Granby coppers," coined in 1737, and for other coins, including the first United States coinage, was obtained from Simsbury.[3] The finding of ore in this locality prompted the discovery of the Schuyler mine in New Jersey in 1719. A cobalt mine in Chatham was worked in 1762, and about the same time the Southampton lead mine was opened, but neither of these enterprises met with much success. In 1836 copper was extensively mined at Bristol, the workings being at this time among the most important in the United States. The Ore Hill iron mine of Salisbury in 1849 supplied 16 furnaces in Litchfield county with a fibrous and massive hematite, which furnished forge pig of the finest quality.[4] The most important silver-lead mine in the state was near Middletown. It was opened in 1852, although previously operated to some extent probably many years prior to the Revolutionary War.[5]

Minerals occurring in Connecticut but not reported in commercial quantities during 1902 are numerous. Barytes was mined in New Haven county as early as 1870, but none has since been reported. Bismuth is disseminated in small quantities through the quartz of Fairfield county. Bornite, green carbonate of copper, vitreous copper, copper pyrite, and native copper occur chiefly in Hartford, Litchfield, and New Haven counties. Emery and corundum are found near Litchfield;[6] graphite or plumbago is disseminated through rock in the same county, and glass sand occurs on the shores of Lake Quassapaug. Copper occurs in many forms throughout the state. A number of contact deposits in sandstone at junctures with gneiss were formerly worked, especially at Bristol.[7] Large deposits of infusorial earth and tripoli occur, but no production was reported for 1902. Indications of galena are abundant[8] throughout the state, but there are few localities where lead mining has been carried on to any extent. Manganese ore in small quantities is frequently found in connection with the iron ores of the Salisbury district.[1] Efforts have been made to locate this ore in sufficient quantities to pay for its separation from iron, but they have thus far proved futile. Mica is found near Branchville and New Milford, and molybdenum at Haddam in the gneiss quarries. Niccolite occurs in Middlesex and Fairfield counties, associated with smaltite or gray cobalt ore, which is disseminated in mica slate accompanied by galenite and sphalerite.

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[1] Metallic Wealth of the United States, by J. D. Whitney, page xxii.

[2] Connecticut, by Alexander Johnston, page 3.

[3] Ibid., pages 3 and 4.

[4] Metallic Wealth of the United States, pages xxiii, xxiv, 315, and 463.

[5] Ibid., page 393.

[6] United States Geological Survey, "Mineral Resources of the United States," 1887, page 715.

[7] Ore Deposits of the United States, by James F. Kemp, page 158.

[8] Metallic Wealth of the United States, page 392.

Precious stones—agate, beryl, and topaz—have been reported as found in the state. Pyrites, pyrrhotite, and chalcopyrite occur in various localities. Rutile occurs in Hartford, Litchfield, and Fairfield counties. Some silver is generally found in the galena of the Eastern states,[2] but the ores have never yet proved abundant enough to be important. Talc occurs with slate in gneiss near Bristol, Hartford county, and a silicate of zinc is found, in Fairfield county, in white limestone with galena and blende.[3]

The following table shows the value of the manufactured products of the state in 1900 based primarily upon the products of mining and quarrying in comparison with the total for all manufactures reported:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$352,824,106
Based upon products of mines or quarries:		
Chemicals and allied products	$852,860	
Clay, glass, and stone products	3,167,010	
Iron and steel and their products	61,079,340	
Metals and metal products, other than iron and steel	78,826,528	
Miscellaneous industries	14,445,102	
		158,370,840
All other		194,453,266

As shown in the above table, the product of mines and quarries was used as material in the manufacture of 44.9 per cent in value of the manufactures of Connecticut. Most of this mineral product was obtained from other states.

The value of the manufactured product reported for 1900 was $352,824,106, while the value of the product of mines and quarries in 1902 was $1,425,959. From these figures it will be seen that the production of mines and quarries represents only four-tenths of 1 per cent of the total value for the combined industries, and manufactures, 99.6 per cent. The manufacturing industries as reported in 1900 gave employment to 176,694 wage-earners who were paid $82,767,725 in wages; in 1902 there were employed at the mines and quarries 1,497 wage-earners who received $808,772 in wages. Of the combined totals, mines and quarries gave employment to eight-tenths of 1 per cent of the wage-earners and paid 1 per cent of the wages, while manufactures employed 99.2 per cent of the wage-earners and paid 99 per cent of the wages.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Siliceous crystalline rocks.	Limestones and dolomites.	Sandstones and quartzites.	Feldspar.
1890	$1,061,292	$131,697	$920,061	(1)
1891	1,167,000	100,000	750,000	(1)
1892	700,000	95,000	650,000	(1)
1893	652,459	155,000	570,346	(1)
1894	594,390	204,414	322,984	(1)
1895	779,361	154,333	397,853	(1)
1896	794,325	138,945	426,029	$5,050
1897	616,215	178,410	364,604	24,875
1898	682,768	142,067	215,733	[2] 12,020
1899	516,886	162,388	271,623	[2] 19,405
1900	507,754	148,060	192,593	[2] 68,300
1901	616,651	140,124	146,814	54,858
1902[3]	812,141	205,371	128,579	73,764

[1] Not reported.
[2] Includes value produced in New York in 1898 and 1900, and Maine in 1898.
[3] Census figures.

The principal mineral production in Connecticut is from quarries, siliceous crystalline rocks leading, although this industry has materially decreased since 1891. The production of sandstones and quartzites has also fallen off largely, but the production of limestones and dolomites increased from $131,697, in 1890, to $205,371, in 1902, or 55.9 per cent.

Siliceous crystalline rocks.—The production of siliceous crystalline rocks in 1902 was valued at $812,141. Of this amount, 43.2 per cent was stone sold in the rough or dressed for building purposes and 36.3 per cent was crushed rock for roads, railroad ballast, and concrete; the remainder being dressed for monumental purposes, made into paving blocks, or prepared for use as curbing, flagging, riprap, rubble, etc.

Extensive deposits of granite are found throughout the New England states, the Connecticut product being usually distinguished from other granites by a fine grain and light gray color.[4] The most important quarries in Connecticut are found bordering on Long Island sound, although a production was reported during 1902 in every county except Tolland.

At Millstone, New London county, is a quarry from which millstones were quarried for use in old-fashioned windmills a century and a half ago. The stone is rather dark colored and is now used chiefly for building, monumental work, and for paving blocks. Monumental stone is quarried only at Groton, the granite being fine grained, hard, and well adapted to this use. The Waterford granite is a fine grained biotite, gray in color, and suitable for both monumental and building purposes. A considerable production was reported in 1902. A gray stone is also quarried near Oneco in Windham county.

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[1] Eleventh Census, Report on Mineral Industries, page 297.
[2] Ore Deposits of the United States, page 201.
[3] United States Geological Survey, "Mineral Resources of the United States," 1887, pages 715 and 716.
[4] Tenth Census, Special Report on Building Stones, Vol. X, page 120.

At Leetes Island, New Haven county, a feldspathic pink gneiss, excellent for heavy construction and bridge work, is quarried. This stone was used in the foundation of the Bartholdi Statue of Liberty in New York harbor. The Stony Creek quarries produced large quantities of red granite, which was used chiefly for building purposes. The red or pink color of this stone is most attractive. At Ansonia and numerous other points there are quarries of more or less importance. There is a large quarry at Sachem Head, which, however, did not report any production during 1902.[1]

Limestones and dolomites.—The production of limestone during 1902 was valued at $205,371, an increase of 46.3 per cent over the production reported for 1901. All the Connecticut limestones are crystalline in texture[2] and comparatively free from admixture of clay or magnesia, and are therefore well adapted for burning into lime, for which purpose, except a very small amount reported as flux, the production of 1902 was wholly used. That limestones are not used in this state for roadmaking material is accounted for by the abundance of the harder and more permanent granitic rocks.

Sandstones and quartzites.—Third in importance among the mineral industries of Connecticut is the quarrying of sandstone, the value of the product for 1902 being $128,579. The quarries are found principally adjacent to the Connecticut river, at Portland, Middlesex county. A small production is also reported from Hartford and New Haven counties. This stone is sold chiefly in the rough and used for building purposes. It quarries easily, works well,[3] and possesses a very rich color, but sometimes does not weather well in the changeable climate of northern United States.

Feldspar.—Connecticut, in 1902, produced in value 29.5 per cent of the feldspar reported for the United States. It was quarried in Fairfield, Hartford, Litchfield, and Middlesex counties. It is obtained from pegmatitic dikes[4] occurring in gneisses and schists and is chiefly orthoclase. In some localities there are large masses of nearly pure spar, but generally the occurrence is an intergrowth of quartz and feldspar. The associated minerals are tourmaline, garnet, and beryl.

Crystalline quartz.—The crystalline quartz quarried during 1902 amounted to 10,400 short tons, and was valued at $32,075, or about three-fourths of the value reported for the entire United States. The mines are situated at New Milford, Roxbury, and Washington in Litchfield county, and at Southbury, New Haven county. Crystalline quartz is used in wood finishing, to prepare the surface of the wood for polishing, and in the stone cutting trade,[5] especially by the marble men, as an abrasive. It is also crushed and sized for use in the manufacture of sandpaper or pulverized for sale as tripoli.

Flint.—The flint production of Connecticut during 1902 was reported as 852 short tons of crude, valued at $1,775, and 960 short tons of ground, valued at $9,800, a total valuation of $11,575, which is somewhat less than was reported in 1901. The quarries are all located in Fairfield and Litchfield counties.

All other minerals.—A considerable amount of marble was quarried near East Canaan, Litchfield county, during 1902, and it was all used for building purposes. Deposits of serpentine[6] and verd antique marble occur in the vicinity of New Haven, but no quarrying was reported.

Iron ore of importance is mined in the extreme northwest corner of the state, near Salisbury, Litchfield county.[7] The ores are similar to those of Massachusetts. Statistics of the production, which is small, have been for some years consolidated with the production of other New England states and can not be shown separately for 1902 without disclosing the business of the only operator engaged in the mining. The Salisbury mines, two in number, are among the oldest in the country, and have been famous for the quality of their ore and the uses to which the iron made from it has been put.

One kaolin mine was reported in Litchfield county, statistics for which are included under "all other minerals" to avoid the disclosure of individual operations. In Litchfield county, in the vicinity of Roxbury, are also located 2 garnet quarries. A large portion of the product is used in the manufacture of sandpaper.

More than one-fifth of the entire asbestos production of the United States is mined in Litchfield county. During 1902 the asbestos produced in this state was chiefly in the crude form. Crushing the ore and separating it by sifting are the only processes thus far undertaken at the mine.

A small quantity of scheelite, which when refined assays about 79 per cent tungstic acid, was mined during 1902, near Longhill, Fairfield county. It occurs in a quartz vein between an amphibole gneiss and a bed of crystalline limestone.[8]

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[1] United States Geological Survey, Nineteenth Annual Report, Part IV, continued, 1897-98, pages 232 to 258.

[2] Tenth Census, Special Report on Building Stones, Vol. X, page 107.

[3] Ibid., page 108.

[4] The Mineral Industry, 1898, Vol. VII, page 266.

[5] United States Geological Survey, "Mineral Resources of the United States," 1901, page 800.

[6] Tenth Census, Special Report on Building Stones, Vol. X, page 129.

[7] Metallic Wealth of the United States, page 462.

[8] The Mineral Industry, 1900, Vol. IX, page 658.

DELAWARE.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Delaware for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Siliceous crystalline rocks.	Clay.
Number of mines or quarries	12	6	6
Number of operators	12	6	6
Salaried officials, clerks, etc.:			
Number	29	16	13
Salaries	$28,047	$15,307	$12,740
Wage-earners			
Average number	504	335	169
Wages	$222,622	$153,150	$69,472
Miscellaneous expenses	$39,278	$19,688	$19,590
Cost of supplies and materials	$45,361	$18,126	$27,235
Value of product	$448,467	$276,753	$171,714

The mineral wealth of the state consists chiefly of its deposits of granitic building stones, which have been extensively quarried, and clay deposits, which were among the first in the country to be developed on a commercial scale. While the state was not a producer in 1902 of feldspar, bog iron ore, greensand marl, limestone, and "blue rock," these minerals occur at various points and were mined in former years. Among the minerals occurring in the state which, as yet, have received little or no attention by miners are: Asbestos, amber, and serpentine.[1]

Certain manufacturing industries are closely allied to or are based on the mining industry, using as their raw material the product of the mine or quarry. The relative importance of these branches of manufacture, as indicated by the value of their products, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$45,387,630
Based upon products of mines or quarries		
Iron and steel and their products	$9,233,012	
Clay, glass, and stone products	723,775	
Metals and metal products, other than iron and steel	275,367	
Chemicals and allied products	883,558	
Miscellaneous industries	1,509,955	
		12,625,667
All other		32,761,963

The total value of the products of the manufacturing industries, based on the products of mining, was, as shown by Table 2, $12,625,667, or 27.8 per cent of the total value of the product of all manufacturing industries in the state in 1900. During the same year there were employed in all branches of manufacture in the state 22,203 wage-earners, who were paid $9,259,661 in wages. In 1902 the mines and quarries of the state gave employment to 504 wage-earners, who received $222,622 in wages. Manufactures, therefore, gave employment to 97.8 per cent of the wage-earners and paid 97.7 per cent of the wages; mining employed 2.2 per cent of the wage-earners and paid 2.3 per cent of the wages.

Table 3 shows the annual production of siliceous crystalline rocks and clay.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Siliceous crystalline rocks.	Clay.
1890	$211,194	(1)
1891	210,000	(1)
1892	250,000	(1)
1893	215,964	(1)
1894	173,805	(1)
1895	73,138	(1)
1896	67,775	(1)
1897	272,469	$99,441
1898	677,754	82,296
1899	1,039,349	71,742
1900	608,028	102,105
1901	671,201	112,883
1902[2]	276,753	171,714

[1] Not reported separately. [2] Census figures.

Siliceous crystalline rocks.—The granitic deposits of the state are confined, in the main, to a comparatively small belt or area adjacent to the city of Wilmington.[2] The rock is of a dark gray gneissoid character and has been used to a limited extent for building purposes, but has been more largely used in coarser construction work and in roadmaking.[3] This rock has been quarried for many years.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1887, page 718.

[2] The New International Encyclopedia, Vol. V, page 768.

[3] Stones for Building and Decoration, by George P. Merrill, page 55.

Clay.—The clays of Delaware constitute the major part of its mineral wealth. A large proportion of the workable deposits, comprising clays suitable for brick and terra cotta making and for china clay, occur in Newcastle county.[1] The clay product of chief importance, however, and that in the production of which the state holds a conspicuous place, is kaolin. The beginning of the industry of kaolin mining in Delaware is approximately coincident with that of the same industry just over the line in Pennsylvania, where it began in 1839.[2] For many years the kaolin deposits of these two states made up the total output of the country. While kaolin of excellent quality and of extensive occurrence has been mined at many different places, the present center of the industry of kaolin or china clay mining is in the vicinity of Hockessin, in Newcastle county. The industry of mining is supplemented in Delaware by the conversion of the raw kaolin into china clay, and the bulk of the state's product of this mineral is shipped in this form.

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[1] The New International Encyclopedia, Vol. V, page 76.

[2] The Mineral Industry, 1898, Vol. VII, page 153 ff.

FLORIDA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Florida for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Phosphate rock.	Limestones and dolomites.	All other minerals.[1]
Number of mines or quarries	71	61	6	4
Number of operators	46	36	6	4
Salaried officials, clerks, etc.:				
Number	218	192	3	23
Salaries	$228,868	$206,108	$2,410	$20,350
Wage earners:				
Average number	3,146	2,866	87	193
Wages	$1,082,030	$996,801	$28,064	$57,175
Contract work	$4,021			$4,021
Miscellaneous expenses	$304,142	$283,149	$2,208	$18,785
Cost of supplies and materials	$618,057	$542,322	$14,769	$60,966
Value of product	$2,943,806	$2,655,463	$63,571	$224,772

[1] Includes operators as follows: Clay, 2; fuller's earth, 2.

The state ranked thirty-fifth in 1902 in the value of products of mines and quarries, with a total of $2,943,806. The mining industry in the state is confined to nonmetallic minerals. Chief among these, both in extent and development, is phosphate rock. Also, in a relative sense, the state's product of fuller's earth is of importance and its wealth in clay deposits is worthy of note.

Other minerals found in the state but not commercially produced in 1902 are: Gypsum, a rather extensive bed of which has recently been discovered near Panasoffkee;[1] lignite or brown coal, deposits of which occur on the Suwanee river, and at one time were worked for fuel;[2] and hydraulic cement rock, of which a large deposit occurs near River Junction, extending for several miles along the left bank of the Apalachicola river southerly to Aspalaga, and comprising over 2,000 acres, with a thickness of at least 80 feet. Enough has been exposed to indicate that the deposit contains sufficient raw material to produce over two billion barrels of cement. The raw material is white, and the manufactured product is as white as the whitest marble.[3]

Development work in the state in 1902 was confined to phosphate rock, clay, and petroleum, cost $25,314, and was of interest chiefly because of the borings and testings made in Sumter county for petroleum.

Certain manufacturing industries use as their raw material the product of the mine or quarry, and their relative importance, as indicated by value of products, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$36,810,243
Based upon products of mines or quarries:		
Chemicals and allied products	$500,239	
Clay, glass, and stone products	229,447	
Iron and steel and their products	320,507	
Metals and metal products, other than iron and steel	125,458	
Miscellaneous industries	981,715	
		2,157,366
All other		34,652,877

The total value of the products of manufacturing industries based on mining was, as shown by Table 2, $2,157,366, or 5.9 per cent of the total value of the products of all manufacturing industries in the state in 1900. During the same year there were employed in all branches of manufactures 34,230 wage-earners, who were paid $10,683,038 in wages. In 1902 the mines and quarries gave employment to 3,146 wage-earners, who received $1,082,030 in wages. Manufactures, therefore, employed 91.6 per cent of the wage-earners of the two industries and paid 90.8 per cent of the wages, while the mining industries employed 8.4 per cent of the wage-earners and paid 9.2 per cent of the wages.

In Table 3 is shown the value of the annual production, as compiled from the reports of the United States Geological Survey, of the principal minerals of the state from 1889 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Phosphate rock.	Limestone.	YEAR.	Phosphate rock.	Limestone.
1889	$32,800	[1]	1896	$1,547,553	$16,982
1890	338,190	[1]	1897	1,493,515	18,889
1891	703,013	[1]	1898	1,847,796	91,330
1892	1,418,418	[2]	1899	2,804,061	44,002
1893	1,979,056	$35,000	1900	2,983,312	128,382
1894	1,666,813	30,639	1901	3,192,472	51,870
1895	2,112,902	10,250	1902[3]	2,655,463	63,571

[1] Not reported separately. [2] No production. [3] Census figures.

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[1] United States Geological Survey, Twentieth Annual Report, 1898–99, Part VI, page 662.

[2] Ibid., "Mineral Resources of the United States," 1882, page 675.

[3] Ibid., Twentieth Annual Report, 1898–99, Part VI, page 549 ff.

Phosphate rock.—This mineral, which constitutes the state's most valuable resource, occurs principally in a belt extending from Lake Okeechobee on the south to the vicinity of Tallahassee on the north,[1] approximating 240 miles in length and averaging about 30 miles in width. Deposits of commercial value are not continuous throughout this large area, but are widely scattered. Four classes of phosphate rock have been produced. These, in the order of total values of product for the years 1888 to 1902, are: Hard rock, land pebble, river pebble, and soft rock.

The following table shows the product of phosphate rock by classes since its mining began in 1888:

TABLE 4.—*Annual production of phosphate rock by kinds: 1888 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	PRODUCTION (LONG TONS).				
	Total.	Hard rock.	Soft rock.	Land pebble.	River pebble.
Total	6,625,468	3,869,128	30,001	1,739,595	986,744
1888	3,000				3,000
1889	4,100				4,100
1890	46,501				46,501
1891	112,482	57,982	(1)	(1)	54,500
1892	287,343	175,908	6,710	21,905	102,820
1893	438,804	215,685	13,675	86,624	122,820
1894	527,653	326,461		98,865	102,327
1895	568,061	307,098	6,916	181,011	73,036
1896	495,109	296,811	400	97,936	100,152
1897	552,312	360,137	2,300	92,182	97,693
1898	600,894	356,810		165,084	79,000
1899	726,420	460,297		177,170	88,953
1900	706,243	424,977		221,403	59,863
1901	751,996	457,568		247,454	46,974
1902	785,880	429,384		350,991	5,505

[1] Included with hard rock.

Nodular amorphous phosphatic deposits in the state were found widely distributed many years ago. It was not believed at that time, however, that they were of sufficient importance either in quantity or quality to warrant their exploitation.[2] The industry of phosphate mining, which brought the state into world prominence, followed close upon the discovery in 1886,[3] on the Peace river, of phosphate rock of apparently high grade. By 1888[3] tentative operations were under way on this river and they met with such marked encouragement that many who had hitherto remained skeptically watching developments came into the field and the year 1889 saw two companies dredging the river bottom with modern and expensive equipment.[2] Thus the industry began in the state with the mining of river pebble.

At the close of 1888 Mr. Albert Vogt, living near Dunnellon, a village on the Withlacoochee river in Marion county, found fossil sharks' teeth in a white subsoil. Some of this white subsoil, being submitted to a chemist for analysis, was found to contain a large percentage of phosphate of lime. This deposit extended in a more or less "pockety" belt over a considerable district. Active explorations were begun and the known area of beds was rapidly enlarged.[3]

The mining of river pebble grew rapidly from the first, and when, in 1891, the period of speculation and development of the land deposits began to give way to the systematic production of this rock, the industry immediately took first rank. By the end of this year 215 companies had been formed to work the deposits, and the number was constantly increasing.[4]

In 1892 the state succeeded in tripling, as compared with the preceding year, its exports of phosphate rock, compelled consumers to acknowledge the industrial value of the product, and forced the majority of foreign producers from the field.[5] In 1894 the state, by exceeding the production of South Carolina, became the chief producer of phosphate rock in the world, with a product of 527,633 long tons; it has occupied this position ever since.

The hard rock phosphate is white or creamy, and varies in texture and structure. It is mined over a belt reaching from the vicinity of Bay City on the south to the vicinity of Albion on the north, and having an average width of about 10 miles with an area of about 900 square miles.

Land pebble is found in a number of localities in the peninsular portion of the state, the center of production being in Polk county. Between the Peace river and the Gulf its occurrence is general beneath a large part of the surface, and it is also found in varying quantities in many other places. It is essentially a mass of white phosphatic pebbles lying in a matrix of phosphatic clay or sand, usually of the two in combination. The matrix is easily disintegrated by water and the pebbles are washed out by appropriate machinery. The pebbles vary in size from grains to stones 1 inch in diameter, the average size being from one-quarter to one-half inch.

River pebble is found in bars in the rivers of southern Florida, the bulk of the production of this class of rock having been taken from the Peace river. Other rivers carrying the pebble are the Alafia, the two Manatees, and the Caloosahatchee. It has also been found in many other streams entering the Gulf and in Black creek, a tributary of the St. Johns. With these pebbles, the remains of vertebrate animals are often found. In color, the river pebbles are blue or black and in size they vary from 1 inch in diameter down to grains, usually finer as distance down the stream is gained.[6]

The soft rock phosphate occurs both as a deposit by itself and in deposits of hard rock, filling the spaces between the bowlders. It may be either clayey or sandy in its nature.[1]

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[1] The New International Encyclopedia, Vol. VII, page 509.

[2] Phosphates of America, by Francis Wyatt, Ph. D., page 63.

[3] United States Geological Survey, "Mineral Resources of the United States," 1888, page 592.

[4] United States Geological Survey, "Mineral Resources of the United States," 1889 and 1890, page 454.

[5] The Mineral Industry, Vol. I, 1892, page 368.

[6] United States Geological Survey, "Mineral Resources of the United States," 1889 and 1890, page 453.

Limestones and dolomites.—The production of limestone in the state has been limited to the last few years and the aggregate output is not large. It is divided about equally in use between building stone, paving, roadmaking, and jetties, and for burning into lime.[2] Limestone is the underlying rock throughout the state,[3] and its outcroppings in Dade, Washington, and Marion counties were the principal points of production in 1902.

All other minerals.—Clay mining in 1902 was confined to the two counties Lake and Putnam, although many valuable clay deposits have been found at various places in the state. Kaolin beds of superior quality occur in Citrus, Lee, and Hernando counties. In the vicinity of Okahumpka some fine specimens have been found of a clear, white quality, comparing favorably with the kaolin used in New Jersey in the manufacture of porcelain ware. At Bluffsprings, in Escambia county, occurs a bed of potters' clay from which a good quality of sewer pipe can be made.[4]

The great sedimentary kaolin deposits in the vicinity of Villa City, Lake county, on the Palalakaha creek, half way between St. Augustine and Tampa, are remarkably alike for their extent and quality. Prospecting has shown the clay to be some 30 feet in thickness and similar chemically to that of Limoges.[5] What are said to be the purest ball clays found in the United States occur at Edgar, near Leesburg.[6]

Fuller's earth includes a number of clay-like substances having strong absorbent qualities.[7] It is found in many shades of color varying from gray to dark green, turning to white on drying; some varieties are kaolinite and others are smectite.[8] For many years it was employed only as a detergent in fulling cloth, but with the increased production of cottonseed oil, it came to be used for clarifying such oil and also for clarifying lard oil and petroleum.[9] The utility of fuller's earth for this purpose was discovered in the United States.[10] For some years the supply had been drawn principally from England, but the new demand stimulated the search for commercial deposits in this country. In 1893, quite by accident, the first discovery of this useful earth in the United States occurred near Quincy, Fla. An effort to burn brick from a bed of clay failed, the material exfoliating instead of forming a coherent mass. An Alsatian cigarmaker called attention to the close resemblance of this peculiar clay to the German fuller's earth.[9] Investigation followed and the deposit proved to be fuller's earth of a very high grade. Since its discovery practically the entire output in the United States has come from this state. In addition to the deposits in the vicinity of Quincy, others have been found at Mt. Pleasant, Norway, River Junction, Ballards point, near Tampa, and at other points.[11] In 1897 a peculiar chocolate-brown earth was discovered near Ocala, which is claimed to be superior to all other American and to all English fuller's earths as a filtering and clarifying agent for oils.[12]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1889 and 1890, page 453.

[2] Ibid., Sixteenth Annual Report, 1894–95, Part IV, page 496.

[3] The New International Encyclopedia, Vol. VII, page 508.

[4] United States Geological Survey, "Mineral Resources of the United States," 1893, page 614.

[5] Ibid., 1891, page 507.

[6] Ibid., Seventeenth Annual Report, 1895–96, Part III, continued, page 845.

[7] United States Geological Survey, Seventeenth Annual Report, page 876.

[8] Dana's Mineralogy, 1892, page 695.

[9] United States Geological Survey, Twenty-first Annual Report, 1899–1900, Part VI, continued, page 590.

[10] Ibid., Twentieth Annual Report, 1898–99, Part VI, continued, page 741.

[11] Ibid., Seventeenth Annual Report, 1895–96, Part III, continued, page 877.

[12] The Mineral Industry, 1898, Vol. VII, page 271.

GEORGIA.

Table 1 is a summary of the statistics for the productive mines and quarries of the state of Georgia for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Siliceous crystalline rocks.	Marble.	Coal, bituminous.	Iron ore.	Gold and silver.	Limestones and dolomites.	Bauxite.	All other minerals.[1]
Number of mines or quarries	149	26	5	3	19	45	8	16	27
Number of operators	127	24	5	2	13	45	8	3	27
Salaried officials, clerks, etc.:									
Number	304	45	24	24	60	59	15	23	54
Salaries	$209,281	$34,595	$23,060	$20,326	$42,361	$29,708	$6,752	$19,355	$33,393
Wage-earners:									
Average number	2,820	724	310	168	688	331	152	93	351
Total wages	$1,085,017	$382,559	$105,709	$71,649	$229,138	$107,718	$42,516	$39,529	$106,199
Contract work	$122,619			$121,464		$1,030		$125	
Miscellaneous expenses	$231,145	$32,568	$68,557	$18,319	$76,622	$9,684	$3,348	$9,564	$12,483
Cost of supplies and materials	$566,067	$188,278	$77,205	$107,998	$64,932	$33,128	$17,905	$23,917	$52,713
Value of product	$3,117,358	$803,778	$660,617	$589,018	$452,717	$149,150	$111,589	$96,194	$254,395

[1] Includes operators as follows: Asbestos, 1; cement, 2, clay, 7; graphite, 2; infusorial earth, tripoli, and pumice (operator reported under talc and soapstone); manganese ore, 6; mica, 1; mineral pigments, crude, 4; sandstones and quartzites, 1; slate, 1; sulphur and pyrite, 1; talc and soapstone, 1.

The state ranked thirty-fourth in 1902 in the value of products of mines and quarries, with a total of $3.117.358. The scope of this branch of industry in the state is quite broad, nineteen different minerals contributing to the total. Gold and silver, in the production of which in former years the state was conspicuous, are still important products, though not commensurate with the abundant deposits of these metals. In recent years the state's most important mineral products have been granite and marble; the quality of the deposits of both these minerals is high and their quantity practically unlimited. From the bauxite deposits of the state more than three-fourths of the total output of the United States is drawn. The extensive occurrence of limestone, iron ore, and slate also add materially to the state's mineral wealth and promise much for future industrial activity.

In addition to the nineteen minerals produced commercially in 1902, the occurrence of many others has been definitely established. Some of these have been exploited to a limited extent, while with others development work has not passed beyond the incipient stage and still others remain untouched. Among the more important of these is copper ore, which before the Civil War was successfully mined in Fannin and Cherokee counties. Large quantities of high-grade ore have been taken from the mines of these counties and the deposits are undoubtedly of considerable economic importance. Copper ore deposits have also been discovered in Fulton, Paulding, Lumpkin, Haralson, Lincoln, and other counties in the northern part of the state. The most important form of the ore is the copper pyrites.[1]

Extensive deposits of corundum occur in many sections of northern Georgia, but chiefly in Rabun county on Laurel creek, where the first discovery of this mineral in the state occurred in 1871. Between 1880 and 1898 the deposits of this county, together with a deposit at Trackrock, in Union county, were extensively worked; their product was one of the main factors in the corundum trade of the country for abrasive purposes. The low prices prevailing for this mineral during the last few years are chiefly responsible for the mines remaining inactive. Corundum has also been found in Habersham and other counties.[2]

Of the precious stones, amethysts of good quality have been found in Rabun county; rubies and sapphires of small size have been obtained in connection with corundum mining, and green beryl, suitable for cutting, has also been found. Some good moonstones have been cut from the feldspar of Upson county.[3] Several diamonds have been found in Hall county, ranging in value up to $200.[4] Others have been found in Lumpkin, White, and Dawson counties.[5] Opal occurs in some of the clay beds of Washington and Bulloch counties.[5]

Serpentine, one of the most beautiful working stones of the state, occurs in commercial quantities in Cherokee county near Holly Springs, where it has been quarried to a limited extent. The stone is of a dark green color, mottled and streaked with white and black, admits of an excellent polish, and is very highly prized for ornamental purposes.[1] Other minerals are antimony, arsenic, barytes, bismuth, calcite, cyanite, epidote, fuller's earth, garnet, glauconite, gypsum, lazulite, lead, monazite, platinum, rutile, staurolite, tin, tourmaline, and zinc.[2]

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[1] Georgia, Historical and Industrial, page 140.

[2] Ibid., page 133.

[3] Ibid., page 66.

[4] Statistics of Georgia, by George White, page 307.

[5] The Commonwealth of Georgia, by J. T. Henderson, page 140.

Development work in the mineral deposits of the state in 1902 was confined to gold, silver, and copper, $32,657 being expended. Certain manufacturing industries are closely allied to or are based on the mining industry, using as their raw materials the product of the mine or quarry. The relative importance of these branches of manufacture, as indicated by the value of their products, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$106,654,527
Based upon products of mines or quarries		
Chemicals and allied products	$3,549,632	
Clay, glass, and stone products	2,483,831	
Iron and steel and their products	4,100,101	
Metals and metal products other than iron and steel	813,605	
Miscellaneous industries	2,971,110	
		13,918,279
All other		92,736,248

The total value of the products of these manufacturing industries based on mining was, as shown by Table 2, $13,918,279, or 13 per cent of the total value of the product of all manufacturing industries in the state in 1900. During the same year there were employed in all branches of manufactures in the state 83,842 wage-earners, who were paid $20,290,071 in wages. In 1902 there were employed in the mines and quarries of the state 2,820 wage-earners, who received $1,085,047 in wages. Of the combined figures for these two branches of industry, therefore, 96.7 per cent of the wage-earners, receiving 94.9 per cent of the wages, were employed in manufacturing, while 3.3 per cent of the wage-earners, receiving 5.1 per cent of the wages, were employed in mining.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1890 to 1902.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Siliceous crystalline rocks.	Marble.	Iron ore.	Gold and silver.[1]	Limestones and dolomites.
1890	$752,181	$198,250	(2)	$101,318	(2)
1891	760,000	275,000	(2)	80,022	(2)
1892	700,000	280,000	[3] $252,517	95,251	(2)
1893	176,387	251,666	[3] 203,682	100,375	$34,500
1894	511,804	721,185	[3] 165,228	92,095	32,000
1895	508,181	689,229	[3] 250,116	128,520	12,000
1896	274,734	617,880	[3] 150,018	151,776	29,081
1897	146,000	808,056	[3] 166,708	160,076	32,000
1898	559,311	626,808	[3] 129,468	129,246	67,803
1899	411,344	712,864	235,343	113,517	29,786
1900	380,431	631,241	[3] 146,354	[4] 116,948	64,451
1901	761,646	996,549	[5] 258,227	[4] 124,740	85,629
1902[6]	863,778	680,517	432,717	[4] 98,012	111,500

[1] Estimates by Director of the Mint, value of the refined product; silver at coining value. The values given in Table 1 are the values at the mine.
[2] Not separately reported.
[3] Includes production from North Carolina.
[4] Silver at commercial value.
[5] Includes production from North Carolina and South Carolina.
[6] Census figures, except for gold and silver.

Siliceous crystalline rocks.—Georgia ranked eighth in the production of the rocks of this group in 1902. Granites and gneisses of excellent quality for building and monumental purposes, and in practically inexhaustible quantities, occur throughout the middle and northeastern parts of the state. One of the most interesting, and perhaps the largest, granite mass in the world is Stone mountain, located in Dekalb county, near Atlanta. This remarkable mountain of rock, whose barren summit attains an altitude of several hundred feet above the surrounding country, with a circumference at its base of 7 miles,[3] has long been the seat of a very important granite industry,[4] the first operations dating back to 1850.[5] The stone obtained from these quarries is a light colored muscovite granite possessing remarkable strength and quite free from all chemical and physical defects. The stone is extensively used as a building material, and is also largely employed in street improvement. There is probably no granite in the South more widely known and more generally used than that furnished by the Stone mountain quarries. Much of it is shipped beyond the borders of the state.[1]

Another granite, or rather granitoid gneiss, of almost as much economic importance as the Stone mountain granite itself, is the lithonia gneiss. This stone, which differs chiefly from the Stone mountain granite in being laminated, occurs in a considerable area in the eastern part of Dekalb county and in the contiguous parts of Rockdale and Gwinnett counties. The quarries on this belt are very extensive and furnish large quantities of stone for street improvement as well as for general building purposes. Georgia in 1902 ranked first among the states in the production of curbing, of which the greater part was drawn from the quarries on this belt. Granites and granitic gneisses similar to these occur in many other localities in the northern part of the state, but only at a few points have they been quarried to any considerable extent.[1]

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[1] Georgia, Historical and Industrial, page 135.
[2] The Commonwealth of Georgia, page 141.
[3] Statistics of Georgia, page 207.
[4] Georgia, Historical and Industrial, page 134.
[5] Stones for Building and Decoration, by George P. Merrill, page 56.

In addition to the granites and granitoid gneisses mentioned there are other granites of superior quality which are admirably adapted to monumental purposes. These occur mainly in Elbert and Oglethorpe counties. They are fine grained biotite granites unusually free from injurious minerals and admit of a very brilliant polish. They are perhaps unsurpassed in the United States for decorative stonework, and it is only a question of time when the Georgia monumental granite industry will be of very great commercial value to the state.[1]

Marble.—Georgia ranked second among the states in 1902 in the production of marble. The state's prominence as a marble producer is remarkable, in view of the brief period over which the history of this industry extends. The commercial exploitation of the enormous marble resources has been entirely the work of the last two decades. The outcroppings of snowy rock in Pickens county were known to the Cherokee Indians, who formerly inhabited this region, and by them were worked to a limited extent and cut into bowls and various other forms. A good specimen of this handiwork may still be seen in the form of a large circular marble bowl, now used as a flower pot in a yard near the Piedmont quarries. It is remarkably well preserved, and is valued very highly by its present owner.[2]

The first systematic working of these outcroppings was by Mr. Fritz T. Simmons in 1840, in Longswamp valley near the village of Tate. At first all the work required in getting out and polishing the marble, which was then used exclusively for tombstones, was done by hand. About two years after Mr. Simmons had begun work he erected a mill with one gang of saws on the east bank of Longswamp creek, near Marble Hill post office. This was the first mill put up in the state for sawing marble. This mill was a somewhat primitive affair, but in principle it was identical with the best mills in use at the present day. A small product was turned out in a desultory way by this and similar mills in the vicinity during several years, but the local demand for tombstones was easily satisfied and existing conditions did not, therefore, encourage a rapid growth of the industry. In 1854 operators, who ten years before had opened a quarry 2 miles east of Jasper, renewed the work at that place. They erected a mill with four gangs of saws and continued fairly successful operations until the work was abandoned on account of the Civil War. The product of this mill was sold in the surrounding counties through agents, transportation being effected by wagons.[3] At the close of the war operations were again resumed and continued for about two years. Then followed a period of nearly twenty years during which the marble industry, in common with many others, was at a standstill.

In May, 1884, a company was organized with a capital of $1,500,000.[4] This date marks the beginning of a very important epoch in the history of the development of the marble industry on a commercial scale in Pickens county and the state. Prior to this date Georgia marble was practically unknown to the trade as a building or ornamental stone, and had even a very local use for tombstones, but on account of its exceptional quality and unlimited quantity, and the energy and businesslike methods of the operators, it has found its way to all parts of the United States,[4] and even to foreign countries.[5] In many of the finest buildings in the country it has been used for building or ornamental purposes. Among these may be mentioned the capitols of Georgia, Rhode Island, Mississippi, and Minnesota; the United States Government building at Boston; St. Luke's Hospital, New York; and the Corcoran Art Gallery, Washington.[6]

The most valuable marbles of the state are those of the crystalline area, confined in the main to Pickens, Cherokee, Gilmer, and Fannin counties. These marbles occur in a narrow belt which runs parallel to the Atlanta, Knoxville and Northern Railway from near Canton, in Cherokee county, to the Georgia-North Carolina state line, a distance of more than 60 miles. The center of the marble industry of the state is in the vicinity of Tate, Pickens county, just north of the southern end of the belt, where the deposit attains a thickness of 200 feet.[7] The structure of the marble from the different quarries is essentially the same, but there is a marked variation in the color. Some of it is white, some bluish gray with dark blue spots, some with dark blue mottlings, useful for monumental work and interior decorations; others of a variety of shades, such as pink, salmon, rose, and dark green, thus producing rich effects, are especially adapted for wainscoting, panels, counters, table tops, etc.[1]

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[1] Georgia, Historical and Industrial, page 135.
[2] Geological Survey of Georgia, Bulletin No. 1, page 9.
[3] Ibid., pages 10 and 11.
[4] Geological Survey of Georgia, Bulletin No. 1, page 11
[5] Georgia, Historical and Industrial, page 41.
[6] Ibid., pages 41 and 134
[7] Geological Survey of Georgia, Bulletin No. 1, page 21 ff.

In addition to the marbles of the main belt there are also valuable deposits in the northwestern part of the state, especially in Whitfield county. These marbles belong to the same deposits that traverse East Tennessee, which are extensively quarried in the vicinity of Knoxville. The stone has a dark chocolate or light gray color and a rather fine texture. The light gray variety, which is always quite compact and highly crystalline, is traversed by dark zigzag lines that give to the polished surface a very pleasing effect. These marbles, though of great economic value for building purposes, have not as yet been extensively exploited.[2]

Iron ores.—The first iron furnace put into operation in the state was that erected in 1840 on Stamp creek, in Bartow county. Within the following twelve or fifteen years four others were put in blast in the same county. The remains of these old furnaces are still to be seen along Stamp creek and the Etowah river. They were small furnaces of the charcoal type and varied in capacity from 2 to 4 tons a day. The ore was taken from the banks in the vicinity or was picked up from the adjacent fields.[3] The industry, begun on this small scale in Bartow county, rapidly grew in importance and volume until at the opening of the Civil War it had spread to other counties in this immediate section, and with greatly enlarged and improved furnaces the state's output had increased many fold. The passing of the war left the furnaces in ruins, and it was not until 1870 that development of the iron ore deposits of the state was resumed. The Rising Fawn furnace, in Dade county, blowing in for the first time on June 18, 1875, was the first in the United States to use the Whitewell hot blast stove.[4] The industry, however, has never regained its former importance. Three or four modern plants have been manufacturing pig iron in Polk and Floyd counties from the high-grade deposits in the vicinity for a number of years,[5] but the bulk of the crude ore of the state is shipped to the furnaces of other states.[6]

The iron ores of Georgia constitute one of the most valuable of its various mineral products. The deposits, which are quite widely distributed throughout the northern part of the state, consist of the brown ores or limonite, magnetite, and hematite or red ores. The brown ores, which furnish the major portion of the present output, are mined in Bartow, Polk, and Floyd counties. The most abundant deposits of these ores occur in pockets or irregular deposits in the residual clays that have resulted from the weathering of an extensive magnesian limestone formation of the Lower Silurian age, known as the Knox dolomite. The average proportion of metallic iron in these ores runs between 48 and 50 per cent. They occur generally throughout the northwestern part of the state, and to a limited extent in other sections.

The red iron ore is mined in Walker and Chattooga counties.[6] Vast quantities occur in beds which outcrop in sandstone ridges that encircle the Coal Measures or extend parallel with their eastern and western limits.[7] The area underlaid by beds of workable thickness is not less than 350 square miles, and falls mainly within the counties of Dade, Catoosa, Walker, and Chattooga.[8]

The following table, compiled from reports of the United States Geological Survey, shows the output of iron ore from 1890 to 1902, inclusive:

TABLE 4.—*Annual production of iron ores: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1890	244,008	1897	[3]204,639
1891	250,755	1898	[3]160,083
1892	185,654	1899	236,748
1893	[1]186,015	1900	[3]336,186
1894	[2]174,694	1901	[3]215,599
1895	[2]272,014	1902	[3]361,890
1896	[2]175,331		

[1] Includes production from West Virginia.
[2] Includes production from North Carolina.
[3] Includes production from North Carolina and South Carolina.

Gold and silver.—Excepting early and half legendary Spanish working in and near the valley of the Coosa, the first gold mining in the state probably began in 1829. In that year, or shortly after, miners from the placer mines of Burke county, N. C., following the indications, went southward into Georgia, where they discovered gold on Dukes creek, in what is now White county. This discovery was followed in quick succession by others throughout Habersham and Lumpkin counties, and soon hundreds of miners were busily engaged on the various streams in this section in search of the yellow metal. In 1830 Governor Gilmer wrote to John McPherson Berrian, then Attorney-General of the United States, saying: "I am in doubt as to what ought to be done with the gold diggers. They, with their various attendants, foragers, and suppliers, make up between six and ten thousand persons. They occupy the country between the Chestatee and Etowah rivers, near the mountains, gold being found in the greatest quantity deposited in small streams which flow into those rivers."[9] The center of gold mining activity then, as now, was in Lumpkin county, in the vicinity of Dahlonega, which in the Cherokee language means "yellow money," and in the town of Auraria, 6 miles away, so named by John C. Calhoun, who owned a mine near by.[10]

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[1] Georgia, Historical and Industrial, page 41.
[2] Ibid., page 134.
[3] Geological Survey of Georgia, Bulletin No. 10A, page 27.
[4] Iron in All Ages, by James M. Swank, page 280.
[5] Geological Survey of Georgia, Bulletin No. 10A, pages 27 and 28.
[6] Georgia, Historical and Industrial, page 62.
[7] The Commonwealth of Georgia, page 119.
[8] Ibid., page 118.
[9] Geological Survey of Georgia, Bulletin No. 4A, page 29.
[10] The Gold Mines, Scenery, and Climate of Georgia and the Carolinas, by R. C. Stone, page 20.

This region was then known as the Cherokee country, as it was occupied by the Cherokee tribe of Indians. The increasing strife and ill will between the Indians and the white miners, and among the white miners themselves who were quarreling and fighting over the Battle Branch and other gold discoveries, caused Governor Gilmer in June, 1831,[1] to issue a proclamation prohibiting gold mining in north Georgia. A detachment of United States troops was sent to enforce the proclamation. Two miles north of Auraria, or Knucklesville, as it was then called, there was still standing in 1878 the old station house in which General Scott and his troops were stationed to preserve the peace and enforce the law during these turbulent times.[2] Thus the mining industry was temporarily retarded, but the acquisition by the state of the Cherokee country about this time, and the removal of the Indians from it, gave the gold seekers full sway, and a period of great activity immediately ensued.[1] In 1831 the first deposit of gold from the placers of the state was made at the United States Mint.[1] The industry spread rapidly throughout the northern part of the state and the production of gold had reached such volume in 1838 that a branch of the United States Mint was established at Dahlonega. This mint continued in operation for twenty-three years and coined 1,381,784 pieces of gold, valued at $6,115,569. However, much of the product of the state during this period was sent to the Philadelphia and other mints, and the total yield exceeded materially the output of the Dahlonega mint.[3]

Mining activity in the state declined markedly on the discovery of gold in California and ceased almost entirely soon after the opening of the Civil War. As the placer deposits, that gave a basis for the greater part of the industry in its earlier stages, have been largely worked over, attention has been directed more and more in recent years to vein mining. According to the report of the Director of the United States Mint for the year 1882, "the work of the year in Georgia was eminently successful, both in its steady prosecution and increase. New mines were selected with judgment, carefully equipped, and the work for the most part managed with prudence and economy." As a result of the great progress of recent years in deep mining, through the introduction of methods for the economic working of refractory ores, the outlook for the industry in the state is quite promising.[4]

The value of gold and silver produced by the state since the discovery in 1829, as compiled from the reports of the Director of the United States Mint, is $17,105,253.

The gold deposits of the state belong to the Appalachian gold fields, an auriferous belt extending from Nova Scotia to Alabama. In Georgia the belt breaks up into a number of parallels having a northeast-southwest trend. The most important of these are the Dahlonega and the Hall county belts. The Dahlonega belt enters the state from North Carolina in the southwestern part of Rabun county, where valuable placer deposits have been worked at the Smith and Moore Girls mines. Farther to the southwest, in White county, the belt increases in width and the mines become more numerous. As it enters Lumpkin county it again increases in width, reaching its greatest development in the vicinity of Dahlonega. In Dawson county it becomes more or less broken, but upon entering Cherokee it again becomes regular and continues with but few interruptions to the Alabama line. The entire length of this belt is about 150 miles, while its width varies from 1 to 5 miles.

The Hall county gold belt lies some 10 miles east of the Dahlonega belt and parallels it for more than 100 miles, stopping short about 10 miles north of Atlanta. A third belt, which includes the Acworth, Villa Rica, and Bonner mines, traverses Cobb, Paulding, and Carroll counties. Still another belt includes some very important mines in Lincoln, Columbia, McDuffie, and Warren counties, and there are many isolated localities besides in which gold occurs in paying quantities.[5]

Limestones and dolomites.—Limestone suitable for lime, fluxing, and building materials exists in great abundance, especially in the northwestern part of the state. The most extensive of these calcareous formations is the Knox dolomite, a magnesian limestone of great thickness. This formation furnishes much of the lime used in the state as well as a large amount of stone for general building purposes. Other calcareous formations of scarcely less commercial importance are the Bangor and Chickamauga limestones. The Chickamauga stone has been extensively used in the last few years for the foundations of monuments in Chickamauga National Park.[6]

Coal, bituminous.—The coal fields of Georgia, which form the northern extension of the Warrior coal field of Alabama, and which were among the first in the country south of the Ohio river to be worked, are located in the northwestern part of the state, falling in the main within the counties of Dade, Walker, and Chattooga. For fifty years or more mining has been carried on in these fields, the greater part of the product at present coming from Dade and Walker counties.

The coal obtained from all the deposits in the state is an excellent quality of bituminous coal, well suited for coking and steam purposes.

Table 5, compiled from the reports of the United States Geological Survey, shows the annual production from 1884 to 1902, inclusive.

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[1] Geological Survey of Georgia, Bulletin No. 4A, page 30.

[2] The Gold Mines, Scenery, and Climate of Georgia and the Carolinas, page 20.

[3] Geological Survey of Georgia, Bulletin No. 4A, page 31.

[4] Ibid., page 32.

[5] Georgia, Historical and Industrial, page 139 ff.

[6] Ibid., page 136.

TABLE 5.—*Annual production of coal, bituminous: 1884 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1884	150,000	1894	354,111
1885	150,000	1895	260,998
1886	223,000	1896	238,546
1887	313,715	1897	195,869
1888	180,000	1898	244,187
1889	225,934	1899	233,111
1890	228,337	1900	315,557
1891	171,000	1901	342,825
1892	215,498	1902	411,093
1893	372,740		

Bauxite.—The first discovery of bauxite in the United States occurred near Rome, Ga., in 1887, and the first bauxite production reported for the country came from the deposits at Hermitage, in Floyd county, in 1889.[1] Shortly after this date other mines were opened in Floyd, Bartow, and Polk counties, so that following close upon its discovery the mining of the bauxite in the state became a very important and lucrative industry. Georgia, until 1891 the only producer of bauxite, still contributes the greater part of this mineral to the market.

All other minerals.—Asbestos is rather widely distributed throughout the northern part of the state, although systematic investigation has been made of the deposits, and hence not much is known of their commercial value or extent. However, for many years the greater part of the supply of this mineral produced in the United States has come from the deposits of Georgia, the mine supplying the most of this being located on Sal mountain in White county.[1]

The industry of mining hydraulic cement rock in the state began in 1845, in Bartow county, above the Western and Atlantic Railroad. The deposits of the state are of excellent quality and are widely distributed over its northwestern part.[2]

The most valuable and extensive deposits of clay in the state are those of sedimentary origin. They occur in a belt several miles in width from Augusta to Columbus. Some of these clays have been used extensively in the manufacture of wall paper, while others are used in making porcelain, terra cotta, tiling, sewer pipe, pottery, etc. Dr. George E. Ladd, director of the Missouri School of Mines, speaking of the cretaceous fire clays of the state, says: "Some of these kaolins suitable for fire clays are more refractory than any of the noted fire clays of the United States." Fire clays also occur in commercial quantities at other points, and residual and alluvial clays, well suited to the manufacture of bricks and the cheaper grades of crockery, abound in every county in the northern part of the state.[3]

Graphite occurs in large quantities in many counties along the western margin of the crystalline area. It is quite abundant in Bartow county, where it is now mined and used in the crude state as a filler for commercial fertilizers.[4]

A light, porous, siliceous stone occurring in Murray, Chattooga, and other counties in northwest Georgia has been known locally for many years as tripoli. Though different from this mineral in origin it has similar uses in the arts.[5]

For many years the mining of manganese ore has been an important industry in the state. During several of the years since 1880 Georgia has been the chief producer of this valuable mineral in the United States, and since that time has contributed more than one-fifth of the total yield of the country.[6] The manganese ores of the state, like the brown iron ores, are confined chiefly to Bartow, Floyd, and Polk counties, the largest and most productive deposit so far located being near Cartersville in Bartow county.[7]

Mica is quite generally distributed throughout the northeastern part of the state, occurring in many places in commercial quantities.[4]

Ocher deposits of commercial value are of wide occurrence throughout the northwestern part of the state, generally associated with the brown iron ores. These ocher deposits, which are really only a pulverulent form of brown iron ore, are quite free from impurities and well suited for making linoleum and paint. The output of the ocher mines of the state, which is about one-fourth of the yield of the country, is shipped in the main to England, where it is used in the manufacture of linoleum.[7]

Pyrite in great abundance is widely distributed throughout the state, but exists in only a few localities in sufficient quantities to be of commercial importance. Valuable and extensive deposits occur in Lumpkin, Paulding, and Haralson counties, but no development on an extensive scale has yet been done.[8]

Sandstone has been extensively quarried in Catoosa county. This variety of sandstone has a dark brown color and resembles very closely the brown sandstone of the Connecticut valley. It makes a beautiful building material and appears to be quite durable. It is also found in great abundance in the mountain ranges of the northwestern part of the state. Other varieties of sandstone of a light color, and well adapted for building purposes, occur in Lookout, Sand, and Pigeon mountains.[9]

The roofing slates of Georgia occur in great quantities in the northwestern part of the state. The center of the slate quarrying industry in the state is at Rockmart, in Polk county, where the industry has been carried on for a great many years.[9]

Talc occurs in the northwestern part of the state in quantities of economic importance and has been mined in a number of places, especially in Fannin county.

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[1] Georgia, Historical and Industrial, page 133.

[2] Ibid., page 136.

[3] Ibid., pages 136 and 137.

[4] Ibid., page 143.

[5] Georgia, Historical and Industrial, page 144.

[6] The United States Geological Survey, "Mineral Resources of the United States," 1902, page 135.

[7] Georgia, Historical and Industrial, page 139.

[8] Ibid., page 140.

[9] Ibid., page 135.

IDAHO.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Idaho for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Gold and silver.	Limestones and dolomites.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	292	258	14	11	9
Number of operators	290	258	13	10	9
Salaried officials, clerks, etc.:					
Number	354	340	....	1	13
Salaries	$576,690	$550,548	....	$1,232	$24,910
Wage-earners:					
Average number	3,563	3,382	6	7	168
Total wages	$3,903,504	$3,698,345	$3,964	$4,655	$196,540
Contract work	$43,442	$41,642	....	....	$1,800
Miscellaneous expenses	$636,409	$614,670	$110	$615	$21,014
Cost of supplies and materials	$1,626,163	$1,605,696	$1,265	$352	$18,849
Value of product	$8,214,671	$8,177,267	$15,074	$13,777	$8,553

[1] Includes operators as follows: Coal, bituminous, 5; copper, 1; precious stones, 1; siliceous crystalline rocks, 2.

The state ranks fourth in the precious metals, the chief mining industry of the state, and is first in lead production, though the latter occurs as a by-product of gold and silver mining. Gold, silver, and lead mining overshadows all other mine and quarry interests, as the value of these products constituted over 99 per cent of the total mineral products of 1902. The other minerals mined commercially were limestones and dolomites, sandstones, bituminous coal, copper, precious stones, and siliceous crystalline rocks.

Other minerals found in the state, but not reported as mined or quarried in commercial quantities in 1902, are as follows: Antimony, a part of the small amount mined in this country having been furnished by Idaho in 1901 and previous years; marble, which has been quarried to a small extent in former years; mica, mined in former years to some extent in the Roberson mining district, near Moscow, Latah county, and opened up at several other localities;[1] monazite, said to have been found in the gold placers of Oro Fino; nickel ores, reported as occurring at the St. Joe mine, Blackbird, Lemhi county;[2] platinum, which occurs in gold placers of the state;[3] and tungsten ores.[4]

Development work was reported by 325 operators in the gold and silver industry. There were employed on development work 180 salaried officials, clerks, etc., who received $164,560 in salaries, and 852 wage-earners, who were paid $897,412 in wages. There was also paid to 254 employees $158,262 for work done by contract. The miscellaneous expenses amounted to $98,217, and the cost of supplies and materials to $405,058.

The following table shows the value of all manufactured products of this state for 1900 and the value of the products of the manufacturing industries based primarily upon the products of mines and quarries:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product	
All manufactures		$4,020,532
Based upon products of mines or quarries:		
Clay, glass, and stone products	$55,709	
Iron and steel and their products	64,272	
Metals and metal products, other than iron and steel	185,347	
Miscellaneous industries	91,448	
		396,776
All other		3,623,756

The value of the products of manufactures utilizing mine and quarry products was 9.9 per cent of the value of all manufactures. Mines and quarries employed 3,563 wage-earners in 1902, who were paid $3,903,504 in wages. In 1900 manufacturers gave employment to 1,477 wage-earners, who received $862,088 as wages. Mines and quarries, therefore, employed 70.7 per cent of the wage-earners of the two industries and paid 81.9 per cent of the wages, and manufactures employed 29.3 per cent of the wage-earners and paid 18.1 per cent of the wages.

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[1] United States Geological Survey, Twentieth Annual Report, 1898–99, Part VI, page 706.

[2] Ibid., "Mineral Resources of the United States," 1901, page 243.

[3] Ibid., page 231.

[4] Ibid., page 262.

The annual production since 1889 of the leading minerals of the state for which values are reported is shown in the following table:

TABLE 3.—*Value of annual production of principal minerals. 1889 to 1902.*

[United States Geological Survey. "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Silver.[1]	Limestone.	Sandstone.
1889	$2,000,000	$4,885,959	(2)	(2)
1890	1,850,000	4,783,828	$28,545	$2,400
1891	1,680,000	5,216,970	(2)	(2)
1892	1,721,364	4,475,067	5,000	3,000
1893	1,646,900	5,056,259	1,000	2,065
1894	2,308,775	4,879,966	5,315	10,529
1895	1,779,600	4,021,780	7,829	6,900
1896	2,155,300	6,658,457	5,662	16,060
1897	1,701,700	6,336,905	15,568	(2)
1898	1,716,900	6,500,065	3,080	(2)
1899	1,889,000	4,980,105	3,325	(2)
1900	1,724,700	[3] 3,986,042	34,567	438
1901	1,869,300	[3] 3,325,740	21,251	20,843
1902[4]	1,475,000	[3] 3,103,044	15,074	13,777

[1] Estimates of the Director of the Mint as value of the refined product: silver at coining value. The values given in Table 1 are the values at mine.

[2] Not reported separately.

[3] Commercial value.

[4] Census figures, except for gold and silver.

The mineral production at former census years was confined to gold and silver, with the exception of a small copper output in 1889. The gold and silver returns for the several census years, beginning with 1870, are as follows:

YEAR.	Gold and silver.	YEAR.	Gold and silver.
1870	$1,980,341	1889	$6,040,641
1880	2,430,000	1902	5,177,267

Gold.—Gold was found on the Pen d'Oreille river in 1852 by a French Canadian, but not in paying quantities. The mining growth of the state dates from the discovery of the Oro Fino placer mines in 1860.[1] Other discoveries soon followed. The mines at Florence at the head of Meadow creek were discovered in the fall of 1861; at Boise basin, a very rich placer district, in August, 1862; and at Owyhee in 1863. As in all new gold districts the first mining was placer, the location of the vein mines coming later. The Poorman, one of the famous vein mines of the state, was located in the summer of 1865. The gold and silver production of the state in 1866 was estimated at $17,000,000, but with the exhaustion of the rich placers it fell off rapidly. The following table, compiled from the reports of the Director of the Mint, gives the value of the annual production of gold and silver from 1866 to 1888, inclusive; for the subsequent years it will be found in Table 3.

TABLE 4.—*Value of annual production of gold and silver: 1866 to 1888.*[1]

[Estimates by the Director of the Mint.]

YEAR.[2]	Gold and silver.	YEAR.[2]	Gold and silver.
1866	$17,000,000	1872	$2,695,870
1867	6,500,000	1873	2,500,000
1868	7,000,000	1874	1,880,004
1869	7,000,000	1875	1,750,000
1870	6,000,000	1876	
1871	5,000,000		

YEAR.	Gold.	Silver.	YEAR.	Gold.	Silver.
1877	$1,500,000	$250,000	1883	$1,400,000	$2,100,000
1878	1,150,000	200,000	1884	1,250,000	2,720,000
1879	1,200,000	650,000	1885	1,800,000	4,500,000
1880	1,980,000	450,000	1886	1,800,000	3,600,000
1881	1,700,000	1,300,000	1887	1,900,000	3,000,000
1882	1,500,000	2,000,000	1888	2,400,000	3,000,000

[1] Silver at coining value.

[2] Figures prior to 1881 taken from The Mineral Industry, 1892, page 188.

The lowest point was reached in 1878, when the total gold and silver production was $1,350,000.

Lead.—Idaho leads all states and territories in lead, on account of the large deposits of argentiferous galenas of the Coeur d'Alene district, which has furnished the major part of the silver and lead product of the state since the first working of the Coeur d'Alene mines in 1886. With the exception of the year 1899, when the product of Coeur d'Alene was reduced by strikes, Idaho has been the first in lead production since 1896. In 1902 the state produced over 30 per cent of the lead product of the country.

Limestones and dolomites.—None of the quarry industries are extensively developed. There were 13 operators—8 individuals and 5 firms—engaged in working 14 limestone quarries in 1902. The value of the product ($15,074) shows the slight and local character of the industry. Of the product, $13,049 was used for lime and $2,025 for flux.

Sandstones and quartzites.—In the sandstone industry 10 operators—7 individuals, 2 firms, and 1 incorporated company—worked 11 quarries. The value of the product was $13,777, composed of building stone, rough, $7,823; dressed, $434; and rubble stone, $5,520.

Coal, bituminous.—Coal was mined in three counties, Lemhi, Fremont, and Boise, to a very small extent, the total production being 2,030 tons of a value of $5,180. The state is the least important of all the coal producing states.

All other minerals.—The state is not a large copper producer, the output for 1902 being less than a quarter of a million of pounds, but the mines of the Seven Devils district have shipped some high-grade ores, and the development of copper mines at Mackey, in Custer county, and erection of furnaces, give promise of a material increase in the copper product.

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[1] Report of J. Ross Browne in "Mineral Resources of the United States," 1868, page 517 ff.

Opals have been found at a number of points in the state and were produced in 1902 to a small extent from one locality in Owyhee county. In 1890 considerable development was commenced near Moscow, Latah county, where opal occurs in the trachyte rocks and production was continued for a year or two. The output for 1891 was estimated at $5,000. Other occurrences are at Opaline, Owyhee county; near Salmon, Lemhi county, where beautiful opal was found in trachyte bowlders and traced to the parent ledge; and at Panther creek, Lemhi county. Smoky quartz in large crystals, up to 4 and 5 inches in diameter, has been found at Brandy creek, in Lemhi county.

Although the state has an abundance of good building material in the granites and other siliceous crystalline rocks, the demand for it is still small. Two quarries were operated to a small extent.

ILLINOIS.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Illinois for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Limestones and dolomites.	Cement.	Fluorspar.	Lead and zinc ore.	Clay.	Sandstones and quartzites.	Natural gas [1]
Number of mines, quarries, and wells	1,116	875	160	6	5	14	8	18	30
Number of operators	1,013	789	150	6	5	14	7	18	24
Salaried officials, clerks, etc.:									
Number	1,869	1,510	284	50	9	12	2	2	....
Salaries	$1,910,940	$1,564,832	$270,025	$59,259	$5,304	$9,120	$1,200	$1,200	....
Wage-earners:									
Average number	40,523	36,617	3,178	488	71	104	42	22	1
Wages	$26,986,397	$24,876,201	$1,737,363	$251,926	$28,845	$51,565	$19,602	$10,295	$600
Contract work	$26,016	$24,699	....	....	....	....	....	....	$1,317
Miscellaneous expenses	$1,543,903	$1,258,686	$233,379	$35,621	$1,149	$11,079	$1,999	$1,946	$44
Cost of supplies and materials	$3,515,833	$2,834,444	$451,908	$185,881	$17,115	$20,464	$3,916	$1,955	$150
Value of product	$38,234,410	$33,945,910	$3,292,128	$769,251	$123,000	$90,619	$38,463	$32,200	$2,844

[1] Includes petroleum, 1 operator (2 wells).

The coal deposits underlie an extensive area and are part of the Central coal field, which includes Indiana and western Kentucky.[1] The lead mines of the Galena district have been in operation for nearly, if not quite, a century, but to-day more zinc than lead ore is produced. The Niagara limestone of Lemont and Joliet is a fine grained, workable stone, much in demand in the interior states. A good quality of sandstone is also found. Until quite recently the fluorspar mines in the southern part of the state were the only source of supply of this mineral in the United States. There are some petroleum and natural-gas wells, good clay is plentiful, and Portland cement is manufactured in large quantities.[2]

In addition to the minerals referred to in Table 1, iron ore and mineral pigments occur in the state, but were not produced in commercial quantities in 1902. The state ranked sixth in mines and quarries in 1902 according to value of product.

Table 2 presents the value of production of the manufacturing industries of this state, which are based primarily upon the products of mines and quarries, and also the value of all manufactured products in Illinois, as reported to the Twelfth Census.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$1,259,730,168
Based upon products of mines or quarries		
Chemicals and allied products	$9,928,382	
Clay, glass, and stone products	19,208,163	
Iron and steel and their products	160,189,237	
Metals and metal products, other than iron and steel	50,170,681	
Miscellaneous industries	57,436,587	
		296,932,901
All other		962,797,267

The value of the products of manufactures, based primarily upon minerals mined or quarried, as shown by the foregoing table, was $296,932,901, or 23.6 per cent of the total. The value of the total product of mines, quarries, and wells of Illinois in 1902, and manufactures in 1900, was $1,297,964,578, of which manufactures contributed 97 per cent and mines and quarries 3 per cent.

The Twelfth Census shows that on the average 395,110 wage-earners were engaged in manufactures in Illinois in 1900, and that $191,510,962 was paid in wages. The average number of wage-earners engaged in mining in 1902 was 40,523, and the wages paid amounted to $26,986,397. The two industries together gave employment to 435,633 wage-earners during the year, and paid $218,497,359 in wages. Manufactures gave employment to 90.7 per cent of these wage-earners, and paid 87.6 per cent of the wages, while mining employed but 9.3 per cent of the wage-earners, and paid only 12.4 per cent of the wages.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 292.

[2] King's Handbook of the United States, pages 206 and 207.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the production of the leading minerals, except for lead and zinc, for which values can not be obtained, from 1890 to 1902:

TABLE 3.—*Value of annual production of the principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Limestones and dolomites.	Portland cement.	Natural rock cement.	Fluorspar.
1890	$14,171,230	$2,190,607	(1)	[2] $292,784	$55,328
1891	14,237,074	2,100,000	(1)	[2] 276,931	78,330
1892	16,243,645	3,185,000	(1)	[2] 236,438	89,000
1893	17,827,595	2,316,000	(1)	153,039	84,000
1894	15,282,111	2,555,962	$540	133,880	47,500
1895	14,239,157	1,687,662	1,325	171,854	24,000
1896	15,809,736	1,261,359	5,250	217,731	[3] 52,000
1897	14,472,529	1,483,157	26,250	209,000	[3] 37,159
1898	14,567,598	1,421,072	(1)	220,580	(1)
1899	20,744,553	2,065,483	79,500	187,983	[3] 96,650
1900	26,927,185	1,881,151	300,352	129,446	[3] 94,500
1901	28,163,937	2,793,837	581,818	187,936	[3] 113,803
1902[4]	33,945,910	3,232,123	769,251	(5)	123,000

[1] No production reported.
[2] Includes value of packages.
[3] Includes production from Kentucky.
[4] Census figures.
[5] Included in Portland cement.

Coal.—The bituminous coal deposits in Illinois underlie some 35,000 square miles, or about 63 per cent of the area of the state. The coal field extends from the northern boundary of Grundy county west to the Mississippi river, near Rock Island, and south along the Mississippi to the north line of Henderson county, where it leaves the river and inclines eastward to the southern part of Jackson county. Although the first discovery of coal in the United States was made in Illinois by Father Hennepin in 1679, near the present city of Ottawa, there is no probability that any mines were opened in that locality until long after coal mining had begun in the southern part of the state. The first record of coal mining in the state was in 1810, in Jackson county. In 1832 several boat loads were shipped from this locality to New Orleans, and in 1833, 6,000 tons were mined in St. Clair county and taken to St. Louis.[1] Since that date there has been a continual increase in the coal production.

In 1902 coal was mined in 54 counties, 41 of which showed an increase in production over 1901 and 7 a decrease, the remaining 6 counties not being reported in 1901. Sangamon, with an output of 4,172,722 tons, ranked first among the coal producing counties; St. Clair second, with 2,822,248; and Vermilion third, with 2,585,291 tons. Other large coal producing counties are Bureau, Grundy, Lasalle, Macoupin, Madison, and Williamson; each have a production exceeding 1,000,000 tons. Illinois ranked second among the coal producing states.

The 789 coal operators gave employment during 1902 to 36,617 wage-earners, or 90.4 per cent of all wage-earners engaged in mines and mining in the state during the year. They also paid in wages $24,876,201, or 92.2 per cent of all the wages paid in the mining industries of the state.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in Illinois since 1833:

TABLE 4.—*Annual production of coal, bituminous: 1833 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1833	6,000	1868	2,000,000
1834	7,500	1869	1,854,000
1835	8,000	1870	2,624,163
1836	10,000	1871	3,000,000
1837	12,500	1872	3,360,000
1838	14,000	1873	3,920,000
1839	15,058	1874	4,203,000
1840	16,968	1875	4,453,178
1841	35,000	1876	5,000,000
1842	58,000	1877	5,350,000
1843	75,000	1878	5,700,000
1844	120,000	1879	5,000,000
1845	150,000	1880	6,115,377
1846	165,000	1881	7,500,000
1847	180,000	1882	9,115,653
1848	200,000	1883	12,123,456
1849	200,000	1884	12,208,075
1850	300,000	1885	11,834,459
1851	320,000	1886	11,175,241
1852	340,000	1887	12,423,066
1853	375,000	1888	14,328,181
1854	385,000	1889	12,104,272
1855	400,000	1890	15,292,420
1856	410,000	1891	15,660,698
1857	450,000	1892	17,862,276
1858	490,000	1893	19,949,564
1859	530,000	1894	17,113,576
1860	568,000	1895	17,735,864
1861	670,000	1896	19,786,626
1862	780,000	1897	20,072,758
1863	890,000	1898	18,599,299
1864	1,000,000	1899	24,439,019
1865	1,260,000	1900	25,767,981
1866	1,580,000	1901	27,331,552
1867	1,800,000	1902	32,939,373

Limestones and dolomites.—Illinois ranked second among the limestone producing states, the products of its quarries in 1902 being valued at $3,232,123. The rocks represent most of the epochs of the Silurian, Devonian, and Carboniferous ages. A notable limestone is quarried in Will county, in the vicinity of Lemont and Joliet; it is a fine grained, light colored Niagara stone, soft and easily worked, taking readily a smooth surface, but no polish.[2]

Of the 160 producing quarries, 55 had a production valued in excess of $10,000, and only 7 produced stone valued in excess of $100,000. Cook county, with an output valued at $1,418,408, ranked first among the 30 limestone producing counties; Will county second, with a production valued at $485,268; and Kankakee county third, with $256,017.

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[1] Illinois Bureau of Labor Statistics, Twenty-first Annual Coal Report, 1902, page 1.

[2] Stones for Building and Decoration, by George P. Merrill, page 297.

Cement.—A fine quality of magnesian limestone was discovered at Utica, Lasalle county, in 1838, during the construction of the Illinois and Michigan canal, and in the same year a factory was erected for the production of natural rock cement. This plant is still successfully operated. A second factory was built in 1869 at Lasalle, and has since been in continuous operation. The manufacture of Portland cement was first reported from Illinois in 1894, at Oglesby, Lasalle county.[1]

In 1902 there were 4 Portland cement plants in this state. Illinois ranked sixth among the states producing Portland cement at the time of this report.

The following figures from the reports of the United States Geological Survey show the production of cement in this state since 1894:

TABLE 5.—*Annual production of cement: 1894 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Portland cement (barrels).	Natural rock cement (barrels).
1894	300	446,267
1895	750	491,012
1896	3,000	544,325
1897	15,000	510,000
1898	(1)	620,228
1899	53,000	537,094
1900	240,442	369,276
1901	328,925	409,842
1902	767,781	607,820

[1] No production.

Fluorspar.—That this mineral was known long ago is proved by the discovery of fluorspar shaped into ornaments in some of the prehistoric mounds of southern Illinois. The earliest scientific mention of its occurrence was in 1819, which describes specimens obtained in the vicinity of Shawneetown. It was first discovered in Hardin county in 1839, and in 1842–43 mining was first actually commenced. The deposits of fluorspar and galena of Hardin county occur in the limestones which underlie the Coal Measures of the states bordering on the Ohio river.[2] Until 1898 the Hardin county mines near Rosiclare and those in Pope county supplied all the fluorspar produced in the United States,[3] but since 1900 Kentucky has led Illinois in the output of this mineral. A small quantity of fluorspar was produced in Pope county, Ill., in 1902.

The following figures from the reports of the United States Geological Survey show the production of fluorspar in Illinois since 1882, the figures since 1895 being combined with those for Kentucky:

TABLE 6.—*Annual production of fluorspar: 1882 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1882	4,000	1893	12,400
1883	4,000	1894	7,500
1884	4,000	1895	4,000
1885	5,000	1896	[1] 6,500
1886	5,000	1897	[1] 5,062
1887	5,000	1898	(2)
1888	6,000	1899	[1] 15,900
1889	9,500	1900	[1] 18,450
1890	8,250	1901	[1] 19,586
1891	10,044	1902	18,860
1892	12,250		

[1] Includes Kentucky. [2] No production reported.

Lead and zinc ore.—The lead bearing district in the northwestern corner of the state is entirely comprised within the limits of Jo Daviess and Stephenson counties.[4] This district forms a part of the upper Mississippi lead region, which occupies an area of some 3,000 square miles in Wisconsin, Iowa, and Illinois. Lead is supposed to have been observed at several points along the Mississippi river by Le Sueur in 1700, and the lead region of the upper Mississippi was located on a map published in France in 1752. Mining of lead ore in Illinois was probably not in active progress much before 1827,[5] the period of greatest production being from 1840 to 1850.[6] Galena, in Jo Daviess county, has always been the center of lead mining in Illinois, and up to the completion of the railroads was the natural outlet for the lead mined in Wisconsin. Zinc did not come into the market until 1860,[7] since which time its production has increased until it is now much greater than that of lead. In 1902 the production of zinc ore in Illinois amounted to 2,778 tons, while that of lead ore was only 792 tons.

Clay.—The state ranked thirteenth in the production of clay in 1902 according to value, producing 1.9 per cent of the total for the United States. The value of the clay produced by the 7 operators was $38,463.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 792.

[2] Transactions of the American Institute of Mining Engineers, 1893, Vol. XXI, pages 31, 32, and 35.

[3] United States Geological Survey, "Mineral Resources of the United States," 1901, page 879.

[4] Geological Survey of Illinois, 1866, Vol. I, page 155.

[5] Iowa Geological Survey, Vol. VI, pages 15 and 18.

[6] Geological Survey of Illinois, 1866, Vol. I, page 156.

[7] Iowa Geological Survey, Vol. VI, page 18.

Sandstones and quartzites.—Carboniferous sandstones of light and dark brown color and good quality are found near Carbondale, Jackson county. The stone is of medium texture, works readily, and closely resembles some of the Connecticut brownstones.[1] The 18 sandstone quarries operating in Illinois in 1902 were located in Alexander, Carroll, Clay, Fulton, Henry, Jackson, Lee, St. Clair, Whiteside, and Union counties, and produced an output valued at $32,200.

Natural gas.—Natural gas was first discovered in Illinois in Champaign county in 1853. In later years it has been found in many other counties, but the wells generally have been shallow.[2] The natural gas of the state in 1902 came from the wells in Randolph and Bureau counties, the entire production being valued at only $1,844.

There were two petroleum wells in Illinois in 1902. The maximum production of petroleum in the state, 1,460 barrels, was recorded in 1889.

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[1] Stones for Building and Decoration, page 138.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 759.

INDIAN TERRITORY.

Table 1 is a summary of the statistics for the productive mines, quarries, and natural-gas and petroleum wells in Indian Territory for 1902.

TABLE 1.—*Summary: 1902.*

	Total	Coal, bituminous.	Asphaltum and bituminous rock.	All other minerals.[1]
Number of mines, quarries, and wells	79	58	6	15
Number of operators	39	29	6	4
Salaried officials, clerks, etc.:				
Number	260	248	5	7
Salaries	$253,171	$240,581	$4,410	$8,180
Wage-earners.				
Average number	4,814	4,763	28	23
Wages	$3,183,322	$3,154,267	$13,185	$15,870
Contract work	$78,639	$56,010	$1,029	$21,600
Miscellaneous expenses	$366,332	$358,960	$2,213	$5,159
Cost of supplies and materials	$329,063	$320,664	$6,299	$2,100
Value of product	$4,321,380	$4,265,106	$11,754	$44,520

[1] Includes operators as follows: Natural gas, 1; petroleum, 2 (13 wells); and siliceous crystalline rocks, 1.

Investigations as to the geological conditions and formations of Indian Territory began as early as 1819[1] and have been continued from time to time during later years. In 1853 the geologist of the Pacific Railroad expedition, Jules Marcou, made an important reconnaissance of the southern part and gave to the public a better knowledge of the lithology and structure of coals in this vicinity.

Of the total mineral production for 1902 in Indian Territory, 98.7 per cent was coal, bituminous, and the remainder was asphaltum and bituminous rock, natural gas, petroleum, and siliceous crystalline rocks. Considerable development work, chiefly in coal mining, was carried on during the year, $167,261 being expended for this purpose. Copper and gold ores[2] are known to exist in the Wichita mountains, although they were not mined in commercial quantities in 1902. Sandstones and quartzites extend over a large portion of the territory,[1] and limestones and dolomites are found north of the Arkansas river. No sandstone or limestone production was reported during 1902.

The following table presents the value of the products of those manufacturing industries which are based primarily upon the products of mines and quarries and also the total value of the products of manufactures in Indian Territory in 1900:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.		Value of product
All manufactures		$3,892,181
Based upon products of mines or quarries:		
Clay, glass, and stone products	$70,214	
Metals and metal products, other than iron and steel	54,544	
Miscellaneous industries	121,921	
		246,679
All other		3,645,502

The value of the output of the manufactures based primarily upon the products of mines and quarries, as shown in the above table, amounted to $246,679, or 6.3 per cent of the total value of the manufactured product of the territory for 1900, indicating that manufacturing in Indian Territory is but slightly dependent upon mineral industries for its raw or partially manufactured material.

In 1902 there were employed in mining and quarrying in Indian Territory an average number of 4,814 wage-earners who received the sum of $3,183,322 in wages. During the census year of 1900 there was an average number of 1,714 wage-earners engaged in manufactures in the territory, and they received $553,899 in wages. The combined manufacturing and mining industries gave employment to 6,528 wage-earners, who received $3,737,221 in wages. The mines and quarries employed 73.7 per cent of the total number of wage-earners and paid 85.2 per cent of the total wages, while the manufacturing industries employed 26.3 per cent of the total number of wage-earners and paid 14.8 per cent of the combined wages.

Coal, bituminous.—Coal mining is by far the most important mineral industry in Indian Territory. The coal fields occupy all of the area of the Creek nation and parts of the area of the Cherokee, Chickasaw, and Choctaw nations, a total of about 20,000 square miles.[3] These fields bear an intimate relation to the Coal Measures of Oklahoma, Kansas, Arkansas, and part of Texas.[4]

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[1] A Geological Reconnaissance of the Coal Fields of Indian Territory, by Noah F. Drake, Ph. D., page 327.

[2] United States Geological Survey, "Mineral Resources of the United States," 1887, page 730.

[3] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Part III, page 373.

[4] A Geological Reconnaissance of the Coal Fields of Indian Territory, page 360.

The development of coal deposits adjacent to McAlester, began in 1872,[1] where a coal suitable for coking was obtained. In 1881 operations were commenced in the vicinity of Savanna and Lehigh,[1] and in 1885 the first commercial coal production was reported in Indian Territory, amounting to 500,000 short tons.

The following table gives the annual production and value of bituminous coal mined in Indian Territory:

TABLE 3.—*Annual production of coal, bituminous: 1885 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (short tons).	Value.	YEAR.	Quantity (short tons).	Value.
1885	116,429	$750,000	1894	969,606	$1,541,293
1886	534,580	855,328	1895	1,211,185	1,737,254
1887	685,911	1,286,692	1896	1,366,646	1,918,115
1888	761,986	1,432,072	1897	1,336,380	1,737,358
1889	752,832	1,323,807	1898	1,381,466	1,827,638
1890	869,229	1,579,188	1899	1,537,427	2,199,785
1891	1,091,032	1,897,037	1900	1,922,298	2,788,124
1892	1,192,721	2,043,479	1901	2,421,781	3,915,268
1893	1,252,110	2,235,209	1902[1]	2,820,666	4,265,106

[1] Census figures.

The above table shows a steady increase in annual production, with the exception of the years 1889, 1894, and 1897, from the time of the first commercial mining operations up to 1902.

The coal belt is about 65 miles wide where it enters from Kansas near the northeast corner of Indian Territory. It extends southward through the territory and then eastward in an L-shaped formation into Arkansas. The southern branches of Coal Measures, reaching into Texas, are somewhat broken by a covering of Cretaceous deposits.

The coal seams vary considerably in thickness in the different portions of the territory, in some instances being too thin for profitable working. The coal deposits worked near Lehigh and Savanna[2] vary from 3 feet 11 inches to 4 feet 2 inches in thickness, while those of the McAlester district vary from 3 feet 6 inches to 4 feet.

The product of the Lehigh and Savanna mines is more especially adapted to steaming purposes[3] and both these coals are considerably utilized by railroads[4] while the McAlester product is a high-grade coke and gas coal remarkably free from sulphur and other impurities. The Savanna product somewhat resembles[3] that of the McAlester district, but the Lehigh coal, although of good steaming qualities, is not adapted for coking.

Asphaltum and bituminous rock.—The region of asphaltum and bituminous rock deposits in Indian Territory[5] is entirely south of the Canadian river and extends from the eastern to the western boundary of the territory.[6] The asphaltite of eastern Indian Territory is generally of a vein forming variety, jet black in color and brilliant in lustre, and of an exceeding brittleness.

One or two quarries were operated during 1895, but the experiment was not a complete success[7] owing to the hard and irregular formation of the asphaltic lime rock. Further developments have been more successful. In 1898 and 1899[8] new discoveries of asphaltic limestone and sandstone were made in the district adjacent to Dougherty and Davis, and a considerable production, chiefly of mastic, was reported. There were 6 quarries in operation during 1902 reporting a production valued at $11,754; in addition a considerable amount of development work was done by one company.

All other minerals.—One natural gas well was reported in the Creek nation and a considerable product was also obtained from an idle petroleum well in the same locality. As there was but one report, the statistics for natural gas production for Indian Territory can not be separately shown.

There were 13 petroleum wells reported by 2 companies near Bartlesville in the Osage nation and a large product was secured in 1902. Development work is being actively carried on in this vicinity.

One granite quarry was reported for the Chickasaw nation with a large production in 1902. The product is not shown separately, as to do so would disclose the operations of an individual establishment. The granite quarried in Indian Territory is not sold in the rough, but is dressed for building purposes and monumental work or prepared for curbing or concrete before it is placed on the market.

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[1] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Part III, page 386.

[2] Ibid., "Mineral Resources of the United States," 1887, page 244.

[3] Ibid., 1886, page 268.

[4] Ibid., 1883, page 45.

[5] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Part I, page 262.

[6] Ibid., page 265.

[7] The Mineral Industry, 1895, Vol. IV, page 44.

[8] Ibid., 1898, Vol. VII, page 65.

INDIANA.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Indiana for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous.	Natural gas.	Petroleum.	Limestones and dolomites.	Cement.	Sandstones and quartzites.	All other minerals.[1]
Number of mines, quarries, and wells	16,825	339	6,861	9,439	160	9	9	8
Number of operators	3,909	283	880	2,567	156	7	9	7
Salaried employees:								
Number	1,662	637	580	108	266	[illegible]	6	....
Salaries	$1,430,538	$530,492	$447,538	$138,506	$238,186	$71,166	$4,650	....
Wage-earners:								
Average number	16,473	10,993	858	1,163	2,831	568	[illegible]	[illegible]
Wages	$10,729,767	$7,396,425	$586,860	$1,045,925	$1,399,829	$266,949	$19,567	$14,212
Contract work	$2,164,380	$26,603	$1,046,144	$1,091,633				
Miscellaneous expenses	$3,387,668	$449,054	$1,390,855	$1,296,422	$196,907	$53,447	$1,705	$700
Cost of supplies and materials	$3,810,666	$729,104	$1,028,358	$1,125,627	$499,764	$420,168	$3,040	$3,605
Value of product	$28,224,760	$10,369,660	$7,081,344	$6,526,622	$2,865,091	$1,286,228	$37,593	$27,622

[1] Includes operators as follows: Clay, 2; oilstones, whetstones, and scythestones, 5 (6 mines); sulphur and pyrite (all data except value of product included with coal, bituminous).

The coals of this state, underlying 7,000 square miles or one-fifth the area of the state, are mostly bituminous, although some block coal is also mined. The petroleum area is steadily increasing, and the natural gas production places Indiana second among states reporting this product. No state possesses better stone for building purposes than Indiana. The production includes the Bedford limestones and the sandstones comprising the so-called conglomerate. Indiana is a large producer of whetstones, the Hindostan whetstone rock having been used for years. The clay deposits are very valuable, and are found in some form in every county. Quantities of white sand suitable for glassmaking occur in various localities. Limonite and siderite iron ore have been found in large quantities in several counties, but they are too siliceous to compete with the rich beds of hematite in other states. The marl deposits are being used more and more in the manufacture of cement.[1]

In addition to the productive mines, quarries, and wells referred to in Table 1, 12 operators reported active mines and wells but no production. These operators paid but $269 in wages during the year, practically all the work being done by contract. For such work $21,979 was paid. Miscellaneous expenses amounted to $6,417, and cost of supplies and materials to $9,118.

The following table shows the value of the products of the manufacturing industries, based primarily upon minerals mined and quarried, and also the total value of the products of all manufactures of Indiana, as reported to the Twelfth Census:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$378,120,140
Based upon products of mines or quarries:		
Chemicals and allied products	$18,113,023	
Clay, glass, and stone products	22,843,090	
Iron and steel and their products	50,884,844	
Metals and metal products, other than iron and steel	4,523,881	
Miscellaneous industries	13,182,452	
		109,547,290
All other		268,572,850

The value of the products of manufactures, based primarily upon minerals mined and quarried, as shown by the foregoing table, is $109,547,290, or about 29 per cent of the total. The total value of the product of mines, quarries, and wells of Indiana in 1902 and manufactures in 1900 was $406,344,900, of which manufactures contributed 93.1 per cent and mines and quarries 6.9 per cent.

The average number of wage-earners reported by the Twelfth Census as engaged in manufacturing was 155,956, and the wages paid were $66,847,317. The average number of wage-earners engaged in mines and quarries in 1902 was 16,473, and the wages paid amounted to $10,729,767.

The two industries combined gave employment during the year to 172,429 wage-earners and paid $77,577,084 in wages. Manufactures gave employment to 90.4 per cent of the wage-earners and paid 86.2 per cent of the wages, while mines and quarries employed only 9.6 per cent of the wage-earners and paid 13.8 per cent of the wages.

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[1] Indiana Department of Geology and Natural Resources, Twentieth Annual Report, 1895, pages 16 to 20.

The following table shows the value of the annual production of the leading minerals of the state, 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal.	Natural gas.	Petroleum.	Limestones and dolomites.	Portland cement.	Sandstones and quartzites.
1890	$3,259,233	$2,302,500	$32,462	$1,889,336	(1)	$43,963
1891	3,070,918	3,942,500	54,787	2,100,000	(1)	90,000
1892	3,620,582	4,716,000	260,620	1,800,000	(1)	80,000
1893	4,055,372	5,718,000	1,050,882	1,474,695	(1)	20,000
1894	3,295,034	5,437,000	1,774,260	1,203,106	(1)	22,120
1895	3,642,623	5,203,200	2,811,444	1,658,976	(1)	60,000
1896	3,261,737	5,043,635	2,954,411	1,658,499	(1)	32,847
1897	3,472,348	5,009,208	1,880,412	2,012,606	(1)	35,561
1898	3,994,918	5,060,969	2,214,322	1,686,572	(1)	45,342
1899	5,285,018	6,680,370	3,363,738	2,173,833	(1)	35,636
1900	6,687,137	7,254,539	4,693,983	2,344,818	$37,500	45,063
1901	7,017,143	6,954,566	4,822,826	2,993,186	240,242	28,334
1902[2]	10,399,660	7,081,344	6,526,622	2,865,691	[3]1,286,228	37,593

[1] No production. [2] Census figures. [3] Includes natural rock cement.

Coal.—The coal area is found in the western and southwestern part of the state, and ranges from 10 to 60 miles in width. The veins of workable thickness vary from 3 to 11 feet, but are in a few places from 25 to 28 feet thick.[1]

The Eastern Interior or Central coal field includes not only the bituminous coal areas of Indiana, but also those of Illinois and western Kentucky; in point of production it ranks second among the bituminous coal producing fields. Father Hennepin first found coal in this field in 1698 on the Illinois river, near Fort Crève-Cœur. This is the first mention of coal found in America. In 1804 coal was noted in the course of land surveys of Indiana, and its position marked on the maps. In 1811 coal dug at Fulton, Perry county, was used by Robert Fulton on the steamboat *Orleans*, and from 1830 to 1860 coal was shipped in a small way out of the state.[2] Since 1860 the mining of coal has steadily increased, and in 1902 Indiana ranked sixth among the bituminous coal producing states, with a total production of 9,446,424 short tons, of which 1,101,544 tons was block coal.

Of the 18 coal producing counties of Indiana in 1902, 13 show an increased production over 1901, the increase in Greene county, 719,164 short tons, being particularly noticeable. Greene county stands first, with a total production of 1,663,785 tons; Vigo second, with 1,652,798 tons; and Clay third, with 1,315,046 tons. Parke and Sullivan counties also contributed over 1,000,000 tons each.

Since 1870 the production of coal in Indiana has amounted to 96,060,655 short tons, as shown in the following table:

TABLE 4.—*Annual production of coal, bituminous: 1870 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
Total	96,060,655	1886	3,000,000
1870	490,414	1887	3,217,711
1871	600,000	1888	3,140,979
1872	896,000	1889	2,845,057
1873	1,000,000	1890	3,305,737
1874	812,000	1891	2,973,474
1875	800,000	1892	3,345,174
1876	950,000	1893	3,791,851
1877	1,000,000	1894	3,423,921
1878	1,000,000	1895	3,995,892
1879	1,196,490	1896	3,905,779
1880	1,500,000	1897	4,151,169
1881	1,771,536	1898	4,920,743
1882	1,976,470	1899	6,006,523
1883	2,560,000	1900	6,484,086
1884	2,260,000	1901	6,918,225
1885	2,375,000	1902	9,446,424

Natural gas.—Although the existence of natural gas in Indiana was known, it was not until after the Trenton rock gas field was opened at Findlay, Ohio, in 1884, that any great attention was given to its development.[3] The knowledge that large quantities of high pressure gas were stored within the Trenton limestone caused a rapid development in this industry. Twenty-six counties contributed to the production in 1902.

Petroleum.—The earliest production of petroleum in commercial quantities was first recorded in Vigo county in 1889.[4] The main Indiana oil field is a continuation of the Lima field in Ohio and extends from the Ohio-Indiana state line westward to Marion, Grant county, and from Warren, Huntington county, south to Hartford City, Blackford county. The greatest length of the field is about 45 miles and its extreme width about 20 miles.[5]

The following table compiled from the reports of the United States Geological Survey shows the annual production of petroleum in Indiana since 1889:

TABLE 5.—*Annual production of petroleum: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels (42 gallons).	YEAR.	Barrels (42 gallons).
Total	45,836,215	1895	4,386,132
		1896	4,680,732
1889	33,375	1897	4,122,356
1890	63,496	1898	3,730,907
1891	136,634	1899	3,848,182
1892	698,068	1900	4,874,392
1893	2,335,293	1901	5,757,086
1894	3,688,666	1902	7,480,896

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[1] Indiana Department of Geology and Natural Resources, Twentieth Annual Report, 1895, page 8.

[2] United States Geological Survey, Twenty-second Annual Report, 1900–1901, Part III, page 294.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 642.

[4] Indiana Department of Geology and Natural Resources, Twenty-first Annual Report, 1896, page 48.

[5] Ibid., Twenty-fifth Annual Report, 1900, page 491.

Limestones and dolomites.—The limestones of Indiana, which are quarried for building purposes, belong either to the Upper Silurian or Subcarboniferous formations in the central and southern parts of the state. The most beautiful and valuable of the oolitic limestones found in Lawrence, Monroe, Owen, Crawford, Harrison, and Washington counties, is that known as "Bedford stone," found near Bedford, in Lawrence county. This rock is of fine, even texture, and is composed of small rounded grains compactly cemented together by crystalline lime or calcite. The stone is soft but tenacious, works readily in every direction, and is used more for carved work than any other domestic limestone.[1]

Of the 36 limestone producing counties of Indiana in 1902 only 6 had an output valued in excess of $100,000. Lawrence county ranked first with a production valued at $1,207,497, or about 42 per cent of the total for the state, which was $2,865,691. Monroe county ranked second and Decatur third.

Cement.—The first Portland cement plant in Indiana, and one among the first in the United States, was constructed at South Bend in 1877. In 1893 this plant was shut down and has not since been a successful producer. In 1900 a new plant was completed at Stroh, Lagrange county, which has since been an increasingly successful producer.[2] Late in the same year another plant was completed near Syracuse, Kosciusko county, but no production was reported until 1901. In 1902 the first production from the plant at Mitchell, in Lawrence county, was reported.[3] In 1900 the single Portland cement plant in Indiana produced 30,000 barrels. In 1901 the two plants produced 218,402 barrels, and in 1902 the three plants produced 536,706 barrels.[3]

Natural cement rock in Indiana was first noticed in Clark county during the construction of the Louisville and Shippingsport canal about 1826. Some time after 1832 a flouring mill, built at Clarksville, Ind., in that year, was changed into the first cement mill to be operated in the state.[4] In 1902 the six plants in Clark county produced 1,343,185 barrels of natural rock cement, valued at $657,984.

Sandstones and quartzites.—The Mansfield sandstone, coarse grained, and gray, yellow, red, brown, or variegated in color, is probably the most important sandstone in the state.[4] The value of the total output of sandstone in Indiana for 1902 was $37,593.

All other minerals.—The value of the clay produced by the two operators who reported, is included with that for other states in order to avoid disclosing individual operations.

The Hindostan whetstone of Orange county is said to have been first discovered in 1810 and the first quarry was opened in 1825.[4] The value of the finished product from the six quarries operated in 1902 was $16,950.

There was a small production of pyrite in Indiana in 1902, which was a by-product of coal mining.

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[1] Stones for Building and Decoration, by George P. Merrill, pages 302 and 303.

[2] Indiana Department of Geology and Natural Resources, Twenty-fifth Annual Report, 1900, pages 24, 27, and 377.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 778.

[4] Indiana Department of Geology and Natural Resources, Twentieth Annual Report, pages 190 and 338.

IOWA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Iowa for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Limestones and dolomites.	Gypsum.	Sandstones and quartzites.	Lead and zinc ore.
Number of mines or quarries	625	326	244	9	32	14
Number of operators	589	297	241	5	32	14
Salaried officials, clerks, etc.:						
Number	610	512	76	20	1	1
Salaries	$500,126	$436,636	$46,775	$15,885	$550	$280
Wage-earners:						
Average number	10,437	9,479	680	253	12	13
Wages	$6,791,161	$6,251,732	$357,249	$170,828	$5,586	$5,766
Contract work	$48,106	$48,046	$60			
Miscellaneous expenses	$373,252	$341,191	$22,518	$6,305	$527	$2,711
Cost of supplies and materials	$961,896	$841,506	$71,261	$47,683	$527	$919
Value of product	$9,676,424	$8,660,287	$649,984	$337,731	$15,061	$13,361

The bituminous coal deposits of Iowa underlie some 20,000 square miles in the southern half of the state and are a part of the Western Interior coal field. Over 10,000 wage-earners are now employed in the coal mines.[1] Large quantities of lead and zinc ore occur in the northeastern part of the state, around Dubuque, but at the present time these minerals are but little mined.[2] The gypsum deposits form one of the most valuable of Iowa's mineral resources.[3]

In addition to the minerals mentioned in Table 1 iron ore and mineral paints are found in Iowa, but these were not produced in commercial quantities in 1902.

Table 2 shows the value of the products of the manufacturing industries, based primarily upon minerals mined and quarried, and also the value of all manufactured products in Iowa, as reported at the Twelfth Census.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$164,617,877
Based upon products of mines or quarries:		
Chemicals and allied products	$402,707	
Clay, glass, and stone products	1,430,652	
Iron and steel and their products	6,138,884	
Metals and metal products, other than iron and steel	2,655,415	
Miscellaneous industries	9,964,093	
		20,591,751
All other		144,026,126

As shown in the foregoing table the value of the products of the manufacturing industries, based primarily upon minerals mined and quarried, was $20,591,751, or about 12.5 per cent of the total value of all manufactured products. The value of the output of the mines and quarries of Iowa for 1902 was $9,676,424, or 5.9 per cent of the total value of product of all manufacturing and mining industries.

The average number of wage-earners engaged in manufactures, as reported at the census of 1900, was 58,553, and the wages paid amounted to $23,931,680. The average number of wage-earners engaged in mining in 1902 was 10,437, and the wages paid were $6,791,161. The manufacturing and mining industries combined, therefore, gave employment during the year to 68,990 wage-earners and paid $30,722,841 in wages. Of these totals, manufactures employed 84.9 per cent of the wage-earners and paid 77.9 per cent of the wages, and mines and quarries employed 15.1 per cent of the wage-earners and paid 22.1 per cent of the wages.

The following table shows the value of the annual production of the principal minerals, 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Coal, bituminous.	Limestones and dolomites.	Gypsum.	Sandstones and quartzites.
1890	$4,995,739	$530,863	$17,350	$80,251
1891	4,807,999	100,000	58,025	50,000
1892	5,175,060	705,000	[1] 104,401	25,000
1893	5,110,460	547,000	56,638	18,347
1894	4,997,939	616,630	44,700	11,639
1895	4,982,102	449,501	36,600	5,575
1896	4,628,022	410,037	31,020	12,341
1897	5,219,503	480,572	64,900	14,771
1898	5,260,716	524,646	45,819	7,102
1899	6,397,338	785,676	285,220	24,348
1900	7,155,341	586,410	361,588	19,063
1901	7,822,805	777,484	[2] 629,336	14,341
1902[3]	8,660,287	649,984	337,731	15,061

[1] Includes production from Colorado, Ohio, Texas, and Utah.
[2] Includes production from Kansas and Texas.
[3] Census figures.

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[1] King's Handbook of the United States, page 259.
[2] Iowa Geological Survey, Vol. VI, page 43.
[3] The Mineral Industry, 1895, Vol. IV, page 379.

Coal.—The area of the coal fields of Iowa is about 20,000 square miles, of which probably one-half is productive.[1] Coal has, without doubt, been mined since the earliest settlement of this area, but no production is recorded prior to 1840, and it was not until after 1852[2] that coal was mined for other than local use.

Of the 24 coal producing counties in 1902, Monroe was first, with 1,406,905 tons; Polk second, and Appanoose third. Other counties having a production in excess of 100,000 tons are Boone, Jasper, Keokuk, Lucas, Mahaska, Marion, Wapello, and Webster.

The figures in the following table are compiled from the reports of the United States Geological Survey, and show the annual production of coal in Iowa since 1840:

TABLE 4.—*Annual production of coal, bituminous: 1840 to 1902.*

[United States Geological survey, "Mineral Resources of the United States"]

YEAR.	Short tons.	YEAR	Short tons.	YEAR	Short tons.
Total	107,596,226	1860	18,253	1882	3,920,000
		1861	50,000	1883	4,457,540
1840	400	1862	53,000	1884	4,370,566
1841	500	1863	57,000	1885	4,012,575
1842	750	1864	63,000	1886	4,315,779
1843	1,000	1865	69,574	1887	4,473,828
1844	2,500	1866	90,530	1888	4,952,440
1845	5,000	1867	150,000	1889	4,095,358
1846	6,500	1868	241,453	1890	4,021,739
1847	8,000	1869	295,166	1891	3,825,495
1848	10,000	1870	283,467	1892	3,918,491
1849	12,500	1871	300,000	1893	3,972,229
1850	15,000	1872	336,000	1894	3,967,253
1851	18,000	1873	392,000	1895	4,156,074
1852	20,000	1874	799,906	1896	3,954,028
1853	23,000	1875	1,231,547	1897	4,611,865
1854	25,000	1876	1,250,000	1898	4,618,842
1855	28,000	1877	1,300,000	1899	5,177,479
1856	30,000	1878	1,350,000	1900	5,202,939
1857	33,000	1879	1,400,000	1901	5,617,499
1858	37,500	1880	1,461,166	1902	5,904,766
1859	42,000	1881	2,500,000		

Limestones and dolomites.—Although limestones and dolomites abound in this state to the exclusion of almost all other varieties of building stone, but little of the material now quarried acquires more than a local reputation.[3] The quarries of the Stone City district in Jones county produce the well-known Anamosa limestone, which was first shipped to any distance in 1859.[4] This stone has found special favor for bridge masonry. Among the 45 counties in which limestone was quarried Jones county ranks first in the value of its output, Jackson county second, and Cedar county third.

Gypsum.—Although the occurrence of gypsum in Iowa has been known for many years, its extent and value has been recognized only recently. To-day it may be considered as forming one of the deposits of greatest value among Iowa's mineral resources.[5] An area of nearly 50 square miles, near Fort Dodge, in Webster county, is known to be covered by the gypsum beds, and this is probably one of the most valuable formations of the kind in the United States.[5] The total amount of available gypsum on the known area is more than 40,000,000,000 tons, and at the present rate of production the supply will last not less than 800,000 years.[5] Nearly the entire production is converted into stucco, or plaster of Paris.

The following table shows the production of gypsum in Iowa since 1889, the figures being compiled from the reports of the United States Geological Survey:

TABLE 5.—*Annual production of gypsum: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1889	21,784	1896	18,631
1890	29,900	1897	22,130
1891	31,385	1898	21,733
1892	12,000	1899	75,574
1893	21,447	1900	184,600
1894	17,906	1901	[1]213,419
1895	25,700	1902	120,779

[1] Includes production from Kansas and Texas.

Sandstones and quartzites.—The 32 quarries operating in 1902 were located in Blackhawk, Cerro Gordo, Clayton, Clinton, Decatur, Des Moines, Fayette, Hardin, Jones, Keokuk, Lee, Marion, Scott, Tama, Van Buren, and Webster counties.

Lead and zinc ore.—The upper Mississippi lead and zinc region, comprising within its limits about 3,000 square miles,[6] embraces the southwest portion of Wisconsin, the northwest corner of Illinois, and the adjoining portion of Iowa, in the counties of Dubuque, Allamakee, and Clayton.

In 1700 Le Sueur is supposed to have observed lead at several points along the Mississippi river, and in 1752 the lead region of the upper Mississippi was located on a map published in France during that year. In 1788 the first mining of lead ore in Iowa was carried on by Julien Dubuque, who had obtained from the Indians a grant or lease of land for mining in what is now Dubuque county. Dubuque continued to develop his prospects until his death in 1810. The most productive period of the Dubuque mines was probably during the years 1835 to 1849.[7]

It was not until 1860[6] that zinc was produced commercially in Iowa. Since then its production has increased until it is greater than that of lead. In 1902 the 14 mines then in operation produced 186 tons of lead ore and 376 tons of zinc ore.

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[1] United States Geological Survey, Twenty-second Annual Report, 1900–1901, Part III, page 340.

[2] Iowa Geological Survey, Vol. II, page 522.

[3] Stones for Building and Decoration, by George P. Merrill, page 304.

[4] The Mineral Industry, 1895, Vol. IV, page 565.

[5] The Mineral Industry, 1895, Vol. IV, pages 379 and 384.

[6] Iowa Geological Survey, Vol. VI, page 18.

[7] Ibid., pages 15 and 16.

KANSAS.

Table 1 is a summary of the statistics of the productive mines, quarries, and wells in the state of Kansas for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Natural gas.	Lead and zinc ore.	Limestones and dolomites.	Petroleum.	Sandstones and quartzites.	All other minerals[1]
Number of mines, quarries, and wells	1,259	175	414	57	115	470	19	9
Number of operators	398	152	37	57	115	12	18	7
Salaried officials, clerks, etc.:								
Number	565	367	43	35	32	33	3	52
Salaries	$527,242	$345,162	$32,012	$21,143	$20,011	$31,664	$3,400	$73,850
Wage earners:								
Average number	8,726	7,017	100	223	606	146	137	497
Wages	$5,686,593	$4,719,595	$65,932	$140,249	$288,347	$108,756	$67,260	$290,434
Contract work	$213,182	$3,641	$107,968	$922	$800	$99,467	....	$981
Miscellaneous expenses	$767,060	$418,921	$40,109	$151,279	$24,378	$51,054	$5,700	$75,539
Cost of supplies and materials	$1,374,535	$596,501	$165,879	$94,315	$51,342	$296,821	$13,944	$165,735
Value of product	$10,700,286	$6,862,787	$824,431	$737,656	$670,796	$292,464	$105,509	$1,206,902

[1] Includes operators, as follows: Cement, 2; gypsum, 5 (7 quarries).

The coal mines of the state compare favorably with those of other coal producing states in the Mississippi valley and the yearly output is increasing. In zinc smelting Kansas ranks second among the states and its lead and zinc mines, although confined to but a few square miles in area, produce annually a large quantity of these ores. The fields of natural gas and petroleum are extensive and are being rapidly developed. The gypsum deposits are large and quantities of cement plasters are manufactured and shipped to all parts of the United States.[1] The manufacture of cement is also a growing industry.

In addition to the minerals referred to in Table 1, clay suitable for the manufacture of tiles, brick, and low-grade pottery, and barite are found in the state, but were not produced in commercial quantites in 1902.

The 18 operators reporting development work, distributed among the industries of natural gas, petroleum, lead and zinc, and coal (bituminous), gave employment during the year to 16 salaried officials, clerks, etc., who received $5,892 in salaries; and to 19 wage-earners, who were paid $16,463 in wages. They also paid $97,511 for work done by contract, which furnished employment to 78 employees. The miscellaneous expenses amounted to $10,956, and the cost of supplies and materials to $90,685.

Table 2 shows the value of the products of the manufacturing industries of the state, based primarily upon the products of mines and quarries, and also the value of all products manufactured in Kansas in 1900.

According to the following table, the value of the products of manufactures, based primarily upon minerals mined and quarried, amounted to $37,060,148, or 21.5 per cent of the total. The combined value of the product of mines and quarries in 1902 and of manufactures in 1900 was $182,829,683, of which manufactures contributed 94.1 per cent and mines and quarries 5.9 per cent.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$172,129,398
Based upon products of mines or quarries:		
Chemicals and allied products	$930,593	
Clay, glass, and stone products	1,810,339	
Iron and steel and their products	3,083,621	
Metals and metal products other than iron and steel	28,698,884	
Miscellaneous industries	1,775,715	
		37,060,148
All other		135,069,250

The average number of wage-earners in Kansas engaged in manufacturing, as reported at the Twelfth Census, was 35,193, and the wages paid amounted to $16,317,689. In 1902 the average number of wage-earners reported as engaged in mining was 8,726, and the wages paid amounted to $5,686,593. The two industries together therefore gave employment to an average of 43,919 wage-earners during the year and paid $21,998,282 in wages. Manufactures, therefore, gave employment to 80.1 per cent of the wage-earners and paid 74.2 per cent of the wages, while mines and quarries furnished employment to but 19.9 per cent of the wage-earners and paid 25.8 per cent of the wages.

Table 3 shows the value of the annual production of the leading minerals of the state from 1890 to 1902.

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[1] Mineral Resources of Kansas, 1897, page 6.

TABLE 3.—VALUE OF ANNUAL PRODUCTION OF PRINCIPAL MINERALS: 1890 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Natural gas.	Lead and zinc.[3]	Limestones and dolomites.	Petroleum.	Sandstones and quartzites.	Cement[4]	Gypsum.
1890	$2,947,517	$12,000	$674,701	$178,822	(2)	$149,289	[5]$122,400	$72,457
1891	3,557,303	5,500	656,374	300,000	(2)	80,000	[5]94,000	161,322
1892	3,955,595	10,795	778,141	310,000	(2)	70,000	[5]77,000	196,197
1893	3,375,740	50,000	667,103	175,173	(2)	24,761	21,000	181,309
1894	4,178,998	86,600	686,052	211,039	$40,000	30,265	25,000	301,884
1895	3,481,981	112,400	1,236,311	350,688	26,658	93,394	56,000	272,531
1896	3,295,032	124,750	1,851,838	158,112	51,107	18,804	50,225	118,371
1897	3,602,326	105,700	2,255,153	208,884	32,439	20,953	[4]61,000	189,679
1898	3,703,014	174,640	2,517,029	305,045	35,990	19,528	120,000	191,589
1899	4,478,112	332,592	2,068,142	379,001	52,275	49,629	60,000	217,030
1900	5,454,691	356,900	1,479,288	339,166	69,142	55,173	158,400	150,257
1901	5,991,599	659,173	1,043,725	478,086	154,378	49,901	97,002	[5]629,760
1902[6]	6,862,787	824,431	737,626	670,536	292,164	105,509	[4]1,017,924	[5]807,355

[1] Statistics for 1890 to 1901, inclusive, from "Mineral Resources of Kansas," 1900 and 1901.
[2] Not separately reported.
[3] Includes production from Missouri.
[4] Includes production from Nebraska and Texas in 1897, and Missouri and South Dakota in 1902.
[5] Includes production from Iowa and Texas.
[6] Census figures, except for cement and gypsum.

Coal.—The Coal Measures of Kansas are in the eastern part of the state and cover about 20,000 square miles, of which 15,000 square miles are rated as productive. Of this area, however, only a small proportion is actually producing at this time.[1] The Kansas coal fields are a part of the Western field, which also includes the bituminous coal deposits of Missouri, Nebraska, Arkansas, Indian Territory, and Texas. The coals in the state occur in various shale beds, occupying all positions from the Cherokee shales at the base to the Osage shales more than 2,000 feet higher.[2]

Coal was first mined in the state in southeastern Cherokee county in 1866 by the early settlers of that locality. The coal beds then operated are now entirely abandoned as they were in the thinner and lower veins. Some years later the heavy beds of coal now so extensively mined in Cherokee and Crawford counties were discovered.[3]

The following table, compiled from the reports of the United States Geological Survey, "Mineral Resources of the United States," 1902, shows the annual production of coal in Kansas since 1869:

TABLE 4.—*Annual production of coal, bituminous: 1869 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1869	36,891	1886	1,400,000
1870	38,000	1887	1,596,879
1871	41,000	1888	1,850,000
1872	44,800	1889	2,221,043
1873	56,000	1890	2,259,922
1874	85,000	1891	2,716,705
1875	150,000	1892	3,007,276
1876	225,000	1893	2,652,546
1877	300,000	1894	3,388,251
1878	375,000	1895	2,926,870
1879	460,000	1896	2,884,801
1880	550,000	1897	3,054,012
1881	750,000	1898	3,406,555
1882	750,000	1899	3,852,267
1883	900,000	1900	4,467,870
1884	1,100,000	1901	4,900,528
1885	1,212,057	1902	5,266,065

The 175 coal mines operating in 1902 were located in Atchison, Bourbon, Cherokee, Cloud, Coffey, Crawford, Franklin, Jewell, Labette, Leavenworth, Linn, Osage, and Republic counties. The total output of these mines for that year was 5,266,065 tons, of which Crawford county produced 2,881,274, and Cherokee county 1,849,896.

Natural gas.—The area throughout which gas has been found in greater or less quantities is in the southeastern part of the state, and embraces the counties of Miami, Allen, Neosho, Crawford, Wilson, Montgomery, and Labette. It is found in the sandstones and the more porous beds of the Cherokee shales, which are at the base of the Kansas Coal Measures.[4]

Though gas had been found in prospecting for oil, and had been noticed escaping from springs even as early as 1864,[5] it was not until the completion of the "Acres well" at Iola, Allen county, in 1873 that the development of this industry really began.[6] In 1882 for the first time what could really be called a gas well was struck in Miami county, at Paola.[5] In 1893 a good well was found in Allen county. In 1899 gas was successfully applied to the reduction of zinc ore, and it also began to be used for lighting in many of the large towns in southeastern Kansas, and in the manufacture of brick and hydraulic cement.[4]

The value of the natural gas produced by the 414 wells flowing in 1902 was $824,431, an increase of $165,258, or 25.1 per cent, over 1901.

Lead and zinc ores.—These ores are at present mined only in the extreme southeastern corner of Cherokee county. All the lead and zinc ores shipped from Kansas have been mined in this area, scarcely equal to four miles square.[7]

The lead and zinc ores of southeastern Kansas, or

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[1] The University Geological Survey of Kansas, 1898, Vol. III, page 117.
[2] Ibid., page 140.
[3] Mineral Resources of Kansas, 1897, page 36.
[4] United States Geological Survey, "Mineral Resources of the United States," 1902, page 649.
[5] Ibid., 1886, page 514.
[6] Mineral Resources of Kansas, 1897, page 45.
[7] Ibid., page 23.

Galena district, occur in the Mississippian or Subcarboniferous limestone formation, which has a wide exposure in southwest Missouri, northwest Arkansas, and southeast Kansas.[1]

The first discovery of lead ore was made in Cherokee county in April, 1876, although similar mines had been operated for several years at Joplin and Granby and adjacent points in Missouri. In the spring of 1877 a large body of pure lead ore was discovered. Great excitement ensued, and the narrow Short creek valley was soon a busy scene of activity. Two rival town companies came upon the scene, one of which, obtaining control of considerable land on the south side of the creek, named its town Galena, and the other, having control of the north side, called its town Empire City. At first everything was confusion, no records of the output of ore being made, but after a time order was established.[2] The total value of the output of the products of the mines of Galena-Empire City, at the mines, from 1876 to 1897, inclusive, has been estimated at from $25,000,000 to $26,000,000.[3]

The following table shows the quantity of lead and zinc ores mined in Cherokee county, Kansas, from 1886 to 1902, the figures, except for 1902, being compiled from Table IX of the Annual Bulletin on Mineral Resources of Kansas for 1897:

TABLE 5.—*Production of lead and zinc ores: 1886 to 1902.*

[Mineral Resources of Kansas, 1900 and 1904.]

YEAR.	Lead ore (short tons).	Zinc ore (short tons).	YEAR.	Lead ore (short tons).	Zinc ore (short tons).
1886	2,962	31,768	1895	12,538	41,222
1887	3,073	32,795	1896	14,062	62,252
1888	2,021	33,391	1897	15,135	79,151
1889	3,926	32,950	1898	7,918	74,882
1890	4,174	21,675	1899	6,723	64,708
1891	3,002	20,641	1900	4,958	46,503
1892	7,188	23,841	1901	5,239	33,978
1893	5,140	25,028	1902[1]	3,468	21,642
1894	5,817	28,670			

[1] Census figures.

Limestones and dolomites.—The limestones of the state quarried at present are, almost without exception, of the Carboniferous or Permian age and occur only in relatively thin beds, varying in thickness from a few inches to 8 or 10 feet. They are, as a rule, light in color, soft and porous, and incapable of receiving a polish that would fit them for any form of ornamental work.[4]

Of the 115 quarries operating in 1902 only 15 had a production exceeding $10,000 in value and but 1 over $100,000. Marion county led all other counties of the state in value of production, and Franklin was second.

Petroleum.—The existence of oil springs in Miami and Wyandotte counties had been learned by the earliest settlers of the state from the Indians. While wells were drilled in the early sixties near Paola, in Miami county, practically all prospecting ceased until after the Civil War. The years from about 1871 or 1872 to 1890 constitute a second distinct period in the development of the oil wells of the state. During this period wells were drilled in Miami and Allen counties. It was not, however, until the introduction of larger capital and better methods subsequent to 1890 that the real development of petroleum began in the state.[5]

The present productive petroleum field of Kansas is in the counties of Neosho, Allen, Chautauqua, Montgomery, and Woodson. Of these Neosho county ranks first and Allen county second in point of production.[6]

The following table shows the annual production of petroleum in Kansas since 1889. It is compiled from the reports of the United States Geological Survey:

TABLE 6.—*Annual production of petroleum: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1889	500	1896	113,571
1890	1,200	1897	81,098
1891	1,400	1898	71,980
1892	(1)	1899	69,700
1893	18,000	1900	74,714
1894	40,000	1901	179,151
1895	44,430	1902	331,749

[1] Not reported.

Sandstones and quartzites.—Sandstones are said to occur in several counties in the southwestern part of Kansas, but few if any of these are of such a quality as to acquire other than a local market.[7]

The value of the output of the 19 quarries operated in 1902 was $105,509. Of this amount Bourbon and Phillips counties alone supplied $87,260, or 82.7 per cent. Elk, Labette, Montgomery, Neosho, Pawnee, Wilson, and Woodson counties also produced some sandstone.

All other minerals.—Natural rock cement was first manufactured in the state in 1868 at Fort Scott, Bourbon county, and has since been produced only in that locality.[8] In 1902 there were two plants producing natural rock cement located at Fort Scott, only one of which is included in the census of mines and quarries, as the other purchased all the raw materials it used. The single Portland cement plant in the state, at Iola, in Allen county, began operations in 1900.[1] The statistics for the two plants embraced in the scope of the inquiry are included in "all other minerals" to avoid the disclosure of individual operations.

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[1] Mineral Resources of Kansas, 1897, page 25.

[2] Ibid., pages 17 and 18.

[3] Ibid., page 31.

[4] Stones for Building and Decoration, by George P. Merrill, page 306.

[5] Mineral Resources of Kansas, 1897, pages 44 to 46.

[6] United States Geological Survey, "Mineral Resources of the United States," 1902, page 557.

[7] Stones for Building and Decoration, page 140.

[8] Mineral Resources of Kansas, 1897, page 66.

The gypsum deposits of the state early attracted the attention of geologists and prospectors, the first mention of them being made in 1864.[2] The deposits of gypsum near Blue Rapids, in Marshall county, were the first worked, the first mill being built in 1875.[3] Kansas is one of the leading states in the production of plaster of Paris and its practically inexhaustible deposits of gypsum will long be a source of supply.[4]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 793.

[2] The University Geological Survey of Kansas, 1899, Vol. V, page 40.

[3] Ibid., page 51.

[4] Ibid., page 12.

KENTUCKY.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells of the state of Kentucky for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Limestones and dolomites.	Natural gas.	Petroleum.	Fluorspar.	Sandstones and quartzites.	All other minerals.[1]
Number of mines, quarries, and wells	1,142	523	70	117	392	14	9	17
Number of operators	665	508	69	19	39	10	9	16
Salaried officials, clerks, etc.:								
Number	854	588	68	32	63	31	16	51
Salaries	$666,360	$476,508	$48,405	$34,250	$44,376	$21,107	$10,270	$31,444
Wage-earners:								
Average number	10,654	9,077	774	50	79	193	166	315
Wages	$5,193,792	$4,522,207	$319,700	$27,860	$69,189	$79,107	$63,589	$112,140
Contract work	$224,923	$10,668	$900	$9,297	$194,462	$300	....	$9,296
Miscellaneous expenses	$600,613	$285,792	$14,443	$112,794	$147,295	$22,328	$928	$17,032
Cost of supplies and materials	$1,207,771	$743,313	$54,809	$37,197	$227,822	$13,952	$10,165	$120,513
Value of products	$8,533,423	$6,666,967	$593,747	$365,911	$172,837	$143,110	$128,470	$462,381

[1] Includes operators as follows: Asphaltum and bituminous rock, 5; clay, 5; cement 1 (2 mines); iron ore, 3; lead and zinc ore, 1; oilstones, whetstones, and scythestones, 1.

With extensive coal deposits in both the eastern and western parts of the state, Kentucky ranks eighth among the coal producing states. In limestones and sandstones fit for structural, architectural, and sculptural purposes the state takes high rank. It has excellent iron ores, extensive deposits of superior clays, abundant stores of Chester marls, and notable deposits of fluorspar, carrying lead and zinc. The state also possesses large fields of natural gas and petroleum, and much asphalt rock. It has in abundance the raw materials for the manufacture of both natural-rock and Portland cement.[1]

In addition to the productive properties shown in Table 1, 58 operators reported active mines, quarries, and wells, but no production, in 1902, the work being confined to the development of the properties. These operators employed on an average 33 wage-earners and paid $25,693 in wages during the year. The salaried officials, clerks, etc., received $23,481; the contract work amounted to $185,733; the miscellaneous expenses to $22,857; and the cost of supplies and materials to $67,620.

The value of the products of the manufacturing industries of Kentucky, based primarily upon minerals mined and quarried, and also the value of all manufactured products of the state as reported at the census of 1900, is shown in Table 2.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$154,166,365
Based upon products of mines or quarries.		
Chemicals and allied products	$698,030	
Clay, glass, and stone products	3,088,521	
Iron and steel and their products	12,252,657	
Metals and metal products, other than iron and steel	2,909,676	
Miscellaneous industries	6,255,904	
		25,204,788
All other		128,961,577

The value of the products of manufactures, based primarily upon minerals mined and quarried, as shown by the foregoing table, was $25,204,788, or 16.3 per cent of the total value for all manufactures in the state. The total value of the output of the mines, quarries, and wells of Kentucky, in 1902, was $8,533,423, or 5.5 per cent of the total value of product for all manufacturing and mining industries in the state.

The manufacturing industries of Kentucky were reported at the census of 1900 as employing on an average during that year 62,962 wage-earners, and as paying $22,434,185 in wages. The operators of the mines, quarries, and wells of the state reported that they gave employment to an average of 10,654 wage-earners during 1902, and paid $5,193,792 in wages. The two industries combined, therefore, gave employment to

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[1] Report of the Inspector of Mines of Kentucky, 1901–2, page 290.

73,616 wage-earners and paid $27,627,977 in wages. Manufactures, therefore, furnished employment to 85.5 per cent of the wage-earners and paid 81.2 per cent of the wages, while mining employed 14.5 per cent of the wage-earners and paid 18.8 per cent of the wages.

The following table shows the value of the annual production of the leading minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Limestones and dolomites.	Natural gas.	Petroleum.	Fluor spar.	Sandstones and quartzites.
1890	$2,472,119	$305,314	$30,000	$6,000	(1)	$117,940
1891	2,715,600	250,000	38,993	9,000	(1)	80,000
1892	2,771,238	275,000	43,175	16,400	(1)	65,000
1893	2,613,569	203,000	68,500	1,500	(1)	18,000
1894	2,749,932	113,934	89,200	450	(1)	27,968
1895	2,890,247	154,130	98,700	600	(1)	25,000
1896	2,684,306	135,967	99,000	924	(1)	(1)
1897	2,828,329	40,815	90,000	161	(1)	40,000
1898	3,084,551	83,900	103,133	2,784	[2]$63,050	72,525
1899	3,618,222	178,961	125,745	17,256	[2]96,650	119,982
1900	4,881,577	178,252	286,243	[3]46,782	[2]91,500	56,178
1901	5,213,076	199,567	270,871	[3]111,527	[2]113,803	108,259
1902[4]	6,666,967	593,747	365,611	172,837	143,410	128,470

[1] Not shown separately.
[2] Includes production from Illinois.
[3] Includes production from Tennessee.
[4] Census figures.

Coal.—There are two distinct coal fields in the state, the eastern, a part of the great Appalachian field and the western, a part of the Illinois or Central field. The two fields have an aggregate in Kentucky of 15,680 square miles of coal bearing measures, of which 11,180 square miles are in the eastern field and 4,500 in the western field.[1] A large part of each field is productive, and each contains from nine to twelve workable seams above the conglomerate sandstone series that lie at the base of the coal measures.[1] The eastern field has also from two to six beds included in the conglomerate series.[1] In 51 of the 53 counties in which coal occurs, workable beds are found.[1]

The existence of coal in Kentucky was undoubtedly known as early as 1770[2] and it was being mined in a small way in the western field from 1830 to 1840.[3] From 1840 to 1850 considerable coal was shipped down the Ohio river from Union and Hancock counties.[3] From 1850 to 1870 the state still produced but a few thousand tons, but in the latter year coal mining began on an extensive scale.[3] The first recorded coal production from the state was reported at the census of 1870.

In 1902 the 523 productive coal mines, located in 47 counties, produced 6,766,984 short tons, valued at $6,666,967. The net increase in production over 1901 amounted to 1,296,998 tons.[4] Hopkins county in the western field, with an output of 1,555,084 tons, ranked first in 1902 among the coal producing counties of the state; Muhlenberg in the same field, second; and Whitley county in the eastern field, third. The entire output of western Kentucky amounted to 3,761,606 tons in 1902, and that of eastern Kentucky to 3,005,378 tons.[5]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in the state since 1870:

TABLE 4.—*Annual production of coal, bituminous: 1870 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1870	168,654	1887	1,933,185
1871	250,000	1888	2,570,000
1872	300,800	1889	2,399,755
1873	300,000	1890	2,701,496
1874	360,000	1891	2,916,069
1875	500,000	1892	3,025,313
1876	650,000	1893	3,007,179
1877	850,000	1894	3,111,192
1878	900,000	1895	3,357,770
1879	1,000,000	1896	3,333,478
1880	1,000,000	1897	3,602,097
1881	1,100,000	1898	3,887,908
1882	1,300,000	1899	4,607,255
1883	1,650,000	1900	5,328,964
1884	1,550,000	1901	5,469,986
1885	1,600,000	1902	6,766,984
1886	1,550,000		

Limestones and dolomites.—The most valuable of the oolitic limestones of the state are found in Litchfield, Grayson county, and Princeton, Caldwell county.[6] The oolitic character is marked in these stones, and while a perfect surface can not always be produced, owing to the breaking away of the minute, rounded grains, in the better qualities, sharp edges and smooth surfaces are said to be acquired as readily as on the well-known stone of Bedford, Indiana.[6] The Bowling Green oolite, of Warren county, is of especial value as a building stone.[7] Handsome examples of the Lower Carboniferous limestones are to be found on the Rockcastle and Cumberland rivers, in the southeastern part of the state.[8]

Of the 70 quarries which were productive in 1902, but 21 reported an output in excess of $10,000, and of the 24 counties in which these productive limestone quarries were located, only 2, Jefferson and Jessamine, had a production valued at $100,000 or over. Warren county, with a production valued at $74,154, of which $44,500 was for building purposes, ranked third. The value of the limestone quarried in the state in 1902 was $593,747, which exceeds the amount for 1901 by $394,180.

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[1] Report of the Inspector of Mines of Kentucky, 1901-2, page 305.
[2] One Hundred Years of American Commerce, Vol. I, page 178.
[3] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Vol. III, page 294.
[4] United States Geological Survey, "Mineral Resources of the United States," 1902, page 301.
[5] Ibid., page 385.
[6] Stones for Building and Decoration, by George P. Merrill, page 308.
[7] United States Geological Survey, Sixteenth Annual Report, 1894-95, Part IV, page 500.
[8] Report of the Inspector of Mines of Kentucky, 1901-2, page 349.

Natural gas.—That the presence of natural gas in the state was early known may be seen from the description of the "Burning Spring," in Clay county, by Dr. D. D. Owen, in his report on the state survey for 1854 and 1855.[1] The first well which produced gas in any considerable quantity was drilled in 1863 near Brandenburg, in Meade county. In 1872 the gas from this well was used in making salt.[2] The search for natural gas was stimulated by the discoveries in 1885–86 in Ohio and Indiana.

The principal gas area thus far developed is in Martin county, in the eastern part of the state. The output of the 117 wells which supplied gas in 1902 was valued at $365,611, an increase of $94,740 over 1901.

Petroleum.—The existence of petroleum in Kentucky was undoubtedly known to the earliest settlers through the Indians, but the first known historical facts date from 1818 or 1819, when petroleum flowed so freely from a well dug in Wayne county for salt that it was abandoned for brine. In 1829 the famous American well was bored in Cumberland county near Burksville.[3]

Although operations in the south central oil district of the state have been carried on in a comparatively small way for many years, it has only been quite recently that the quest for oil has been prosecuted with vigor.[4] In 1902 the 392 productive wells, located in Barren, Bath, Clinton, Knox, Morgan, Rowan, Wayne, and Webster counties, produced 248,950 barrels, valued at $172,837. Wayne and Bath counties are the largest petroleum producing counties in the state.

The following figures from the reports of the United States Geological Survey show the annual production of petroleum in Kentucky since the earliest record. The difference between the Census figures and those of the Survey is caused by the fact that the former represent the petroleum produced and the latter the product marketed.

TABLE 5.—*Annual production of petroleum: 1882 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Barrels.[1]	YEAR	Barrels.[1]
1882[2]	160,933	1893	3,000
1883	4,755	1894	1,500
1884	4,148	1895	1,500
1885	5,164	1896	1,680
1886	4,726	1897	322
1887	4,791	1898	5,568
1888	5,096	1899	18,280
1889	5,400	1900	62,259
1890	6,000	1901	137,259
1891	9,000	1902	185,331
1892	6,500		

[1] Includes production from Tennessee.
[2] Includes production previous to 1883.

Fluorspar.—This mineral is found in Crittenden, Livingston, and Caldwell counties associated with lead and zinc. The veins bearing fluorspar occupy fissures in the Carboniferous rocks, following the faultings that reach into the Coal Measures. The fluorite extends through the entire Genevieve group, excepting possibly the upper Chester.[5]

The ore deposits in the section of the state referred to have been known to settlers since early in the last century. The first attempt to mine them was made in Crittenden county by a company headed by President Andrew Jackson. Primitive attempts were also made at mining the ore deposits in Livingston county subsequent to the Civil War, and in 1878 nearly all mining in this district of western Kentucky had ceased. Up to 1878 lead only had been mined in this section, but the demand for fluorspar served to maintain a small interest in mining in the southern part of this district for a few years longer, when, owing to a slight drop in the value of this mineral and the cost of transportation, these mines became incapable of competing with the more favorably located mines on the other side of the Ohio river in Illinois.[6] Since 1898, however, interest in the fluorspar deposits of the state has been revived, and in 1902 Kentucky, with a production of 29,030 short tons of fluorspar from 14 mines in Crittenden, Fayette, and Livingston counties, was the largest producer of this mineral. The value of the state's output was $143,410.

Sandstones and quartzites.—One of the most valuable sandstones for structural purposes is quarried in Rowan county, and several of the sandstones of the Coal Measures are frequently quite good for bridge piers and foundations.[7] The 9 quarries productive in 1902 were located in Breathitt, Knox, Livingston, Rockcastle, Rowan, Warren, and Whitley counties, and had an output in that year valued at $128,470.

All other minerals.—Bitumens in Kentucky occur as impregnations of sandstones.[8] Fine examples are to be found in Breckinridge, Hardin, Grayson, and Logan counties, in western Kentucky, and in Carter county in the eastern part of the state.[9] In 1902 the state's production of bituminous sandstones amounted to 22,498 tons, valued at $68,704.

Fire clays of proved excellence are found in several counties of the eastern coal field and also in the western field. Pottery clays for ordinary use are abundant.[7] In 1902 Kentucky ranked fifteenth among the states in the value of its clay products, which amounted to $1,873,043.[10]

Natural cement rock was discovered in Kentucky in 1829, during the construction of the Louisville and

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[1] Report of the Inspector of Mines of Kentucky, 1901–2, page 111.
[2] United States Geological Survey, "Mineral Resources of the United States," 1892, page 696.
[3] Tenth Census, Vol. X, page 8.
[4] Report of the Inspector of Mines of Kentucky, 1901–2, page 347.
[5] The Mineral Industry, 1893, Vol. II, page 310.
[6] Report of the Inspector of Mines of Kentucky, 1901–2, pages 350 to 352.
[7] Ibid., pages 348 and 349.
[8] United States Geological Survey, Twenty-second Annual Report, 1900–1901, Part I, page 240.
[9] Report of the Inspector of Mines of Kentucky, 1901–2, page 346.
[10] United States Geological Survey, "Mineral Resources of the United States," 1902, page 762.

Portland canal. The manufacture of Louisville cement was commenced in that year at Shippingport, a small suburb of Louisville. The growth of the industry has not been rapid. As but one cement factory quarried its own material in 1902, no figures can be given without disclosing individual operations. The product of Indiana and Kentucky combined was 1,727,146 barrels, valued at $869,163.[1]

That the presence of iron ores in Kentucky was early known is proved by reference made to them in an article written by Thomas Jefferson before the close of the Revolution. The first iron furnace was built in the state in 1791, in Bath county.[2] For a number of years after 1800 the iron industry of the state made rapid progress, and from about 1825 to 1860 was the period of its greatest activity.[3] Although iron ore is found in many counties, both in the eastern and western coal fields of the state, comparatively little mining has been done,[4] and in 1902 iron ore was mined only in Bath, Lyon, and Trigg counties. The total production amounted to 71,006 tons, valued at $86,169. Both brown and red hematite were mined.

The lead and zinc ore deposits in Crittenden county were first mined by a company headed by President Andrew Jackson.[5] Other primitive attempts were made in Livingston county subsequent to the Civil War, but in 1878 nearly all mining in these counties had ceased, owing to cost of transportation and a drop in the price of the ores. These mines are at present being worked principally for the associated mineral fluorspar.[6] As only one operator reported any production of lead and zinc ores in 1902, no figures can be given.

The sandstone used by the single operator reporting oilstones and whetstones comes from Hardin county. No figures can be given without disclosing individual operations.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 783 and 793.

[2] Iron in All Ages, by James M. Swank, page 282.

[3] Ibid., pages 285 and 286.

[4] Report of the Inspector of Mines of Kentucky, 1901–2, pages 339 and 340.

[5] Report of the Inspector of Mines of Kentucky, 1901–2, pages 351 and 352.

[6] Ibid., pages 350, 351, and 352.

LOUISIANA.

Table 1 is a summary of the statistics for the productive mines and wells in the state of Louisiana for 1902.

TABLE 1.—*Summary: 1902.*

	All minerals.[1]
Number of mines and wells	8
Number of operators	3
Salaried officials, clerks, etc.:	
Number	8
Salaries	$7,533
Wage-earners:	
Average number	61
Wages	$31,414
Contract work	$105,858
Miscellaneous expenses	$25,820
Cost of supplies and materials	$7,354
Value of product	$279,327

[1] Includes operators as follows: Petroleum, 2 (7 wells); sulphur and pyrite, 1.

A few minerals of the state which were not produced in 1902, but which occur in sufficient quantities for commercial operations, call for mention. Among them are the sandstones of the hills of the northern part of the state and along the Grand Gulf. Only the latter, however, are of economic value, and these have been quarried extensively for riprap, jetty work, and railroad ballast. Limestones, which occur in beds of limited extent and as concretions, are also found in the state. The outcroppings have been used to some extent for lime, and the concretions have been used for the same purpose and also for road material and for cement.[1] Lignite, which has had only a limited local use for blacksmithing purposes, has been found. Gypsum occurs in several places, especially along the Ouachita river and in association with the sulphur deposits near Lake Charles, the gypsum in these deposits being of exceptional purity.[2]

Development work of considerable importance was carried on during the year, the total expenditure being $92,442. This outlay was confined to well boring and other expense incident to the development of the oil industry.

Petroleum.—Dr. William M. Carpenter, in his Geological Survey of Louisiana (1839), makes the statement that "in the lowlands bordering on the Calcasieu river there are numerous springs of petroleum." It was while boring for petroleum in this region that the discovery of the great sulphur deposit was made. One of the wells sunk here yields a small quantity of petroleum, which some years ago was collected and barreled. Prospecting wells have also been sunk on Belle Isle and in other localities in the state.[2]

Early in 1901 development work was started near Jennings, Welsh, Lake Charles, Sulphur, and a few other places in adjoining parishes. The Jennings Oil Company, drilling in Arcadia parish, 87 miles east of Beaumont, Tex., and about 190 miles west of New Orleans, on the line of the Southern Pacific Railroad, succeeded in finding oil in paying quantities. The company now has two good wells each producing from 2,000 to 2,500 barrels each per day. The Southern Oil Company early in 1902 completed a good well about 100 feet from the Jennings well No. 1, and both companies are making extensive preparations for handling their output.[3]

Sulphur.—There is a very large deposit of this mineral about 13 miles from Lake Charles in Calcasieu parish.[4] In 1868 the Louisiana Oil Company, while sinking a well at this point, struck at a depth of 443 feet a very extensive bed of almost pure sulphur, the analysis showing 99.93 per cent. During 1869 and 1870 other borings showed the average thickness of the deposit to be about 100 feet. Numerous attempts have since been made to exploit it, but the depth of the deposit below the surface and the beds of water-bearing sands which overlie it render mining operations difficult. In 1895 operations were begun with the Frash system, invented by Mr. Herman Frash, of Cleveland, Ohio, and by the use of this method a considerable product was taken from the deposit. The principle of the "air lift" pump was applied in 1896, and by this means a product of 265 tons a day was secured. The production from the mines in 1895 was about 800 tons; in 1896, 4,200 tons; and in 1897, 1,000 tons. Shortly afterwards the mines were closed, as their operation under the adverse conditions was too expensive to leave a reasonable margin of profit,[5] but work of a developing and experimental character ensued for some years, during which period the details of a chemical process for recovering the sulphur were being worked out. Operations, under the new method of mining, were resumed in 1900, and the mine has been a consistent producer since that time.

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[1] Geological Survey of Louisiana, 1899, Part V, page 130 ff.

[2] Ibid., page 137.

[3] United States Geological Survey, "Mineral Resources of the United States," 1901, page 564.

[4] Ibid., 1882, page 687.

[5] Geological Survey of Louisiana, 1899, Part V, page 126 ff.

MAINE.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Maine for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Siliceous crystalline rocks.	Limestones and dolomites.	Slate.	All other minerals.[1]
Number of mines or quarries	135	110	11	7	7
Number of operators	141	103	11	7	20
Salaried officials, clerks, etc.:					
Number	208	163	16	22	7
Salaries	$193,814	$158,516	$13,236	$16,999	$5,063
Wage-earners:					
Average number	3,684	2,832	591	217	44
Wages	$2,284,789	$1,867,200	$288,512	$110,818	$18,259
Miscellaneous expenses	$121,556	$66,413	$37,613	$13,496	$4,034
Cost of supplies and materials	$476,964	$217,548	$226,694	$27,329	$5,393
Value of product	$3,656,134	$2,659,450	$745,132	$206,558	$44,994

[1] Includes operators as follows: Feldspar, 5; flint (operator reported under feldspar); mica, 2; precious stones, 13 (no mines).

As shown in the above table, quarrying is the chief mineral occupation in Maine. The value of siliceous crystalline rocks quarried during the year represents 72.7 per cent of the entire mineral production in the state, and limestone and slate are second and third, respectively, in value of production.

A number of minerals occur, for which no production was reported during 1902, although they were previously mined to a considerable extent. Barytes occurs sparingly in Hancock county. Clay has been mined to some extent, and beds of copper in Washington and Hancock counties have been worked with considerable success. Gold alloyed with platinum has been placer mined in Franklin county; it also occurs with metallic bismuth in Hancock county. Infusorial earth and tripoli are found in Hancock county, in pond bottoms near the coast. Iron ores are found in Aroostook, Washington, Piscataquis, Hancock, Knox, Cumberland, and Oxford counties. Graphite and lead occur in many localities throughout the state. Lead is charged with silver to such an extent that it has been said that "systematic mining might pay" in the districts where it occurs. Manganese is found in Knox, Hancock, Piscataquis, York, and Aroostook counties; marl occurs in the northern part of the state; and ocher may be obtained in Androscoggin and Cumberland counties. Molybdenum sulphide is found in Washington and Hancock counties and pyrite occurs in many localities, but chiefly in Hancock county. Sandstone, silica sand, native silver, talc and soapstone, and zinc blende are other minerals not mined, though found here and there through the state.[1]

Table 2 presents the total value of the products for all manufacturing industries in 1900 together with the totals for those based upon the product of mines or quarries.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$127,361,485
Based upon products of mines or quarries.		
Chemicals and allied products	$143,631	
Clay, glass, and stone products	1,440,963	
Iron and steel and their products	3,869,968	
Metals and metal products, other than iron and steel	912,701	
Miscellaneous industries	7,891,144	
		14,258,440
All other		113,103,045

As shown in the above table, manufactures based primarily upon the products of mines and quarries constitute 11.2 per cent of the total product of all manufactures reported for the state at the census of 1900. The product reported during 1902 by the mines and quarries in the state is valued at $3,656,134, which amount is only 2.8 per cent of the combined value of the products of the manufacturing and mining industries, while manufactures represent 97.2 per cent of this total.

During the census year of 1900 the manufacturing industries of Maine gave employment to an average number of 74,816 wage-earners, who received $28,527,849 in wages. The operators of the mines and quarries in 1902 employed an average of 3,684 wage-earners, and paid $2,284,789 in wages. The combined industries therefore employed 78,500 wage-earners, who received $30,812,638 in wages. Manufacturing gave employment to 95.3 per cent of the wage-earners and paid 92.6 per cent of the wages, while mines and quarries gave employment to 4.7 per cent of the wage-earners and paid 7.4 per cent of the wages.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1887, pages 736 to 739.

The annual production of siliceous crystalline rocks, limestones and dolomites, and slate is given in Table 3 as compiled from the reports of the United States Geological Survey.

TABLE 3.—*Annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Siliceous crystalline rocks.	Limestones and dolomites.	Slate.
1890	$2,225,839	$1,523,499	$219,500
1891	2,200,000	1,200,000	250,000
1892	2,300,000	1,600,000	250,000
1893	1,274,954	1,175,000	139,200
1894	1,551,036	810,069	146,838
1895	1,400,000	700,000	140,154
1896	1,195,491	608,077	124,096
1897	1,115,827	742,877	201,117
1898	1,032,621	1,283,468	199,287
1899	1,321,082	1,028,375	181,766
1900	1,508,573	691,312	177,842
1901	2,703,116	715,272	202,325
1902[1]	2,659,450	745,132	206,558

[1] Census figures.

The above table shows that the production of siliceous crystalline rocks during 1901 was the greatest of any year during the decade, and that the production for 1902 was but slightly less. The production of limestones during 1902 was less than half that reported in 1890, although an increase is shown over both 1901 and 1900. The production of slate in 1902 was greater than for any year since 1892. In that year and in 1891 the maximum production for the thirteen years was reported.

Siliceous crystalline rocks.—The state of Maine, during 1901, held first rank as a producer of granite in the United States, but in 1902 it was second to Massachusetts. The production during 1902 was valued at $2,659,450, of which amount $1,921,020 was the value of stone utilized for building purposes. The stone converted into paving blocks was valued at $354,530; and that for monumental purposes at $208,141. Lesser amounts for stone utilized as curbing, flagging, riprap, rubble, crushed stone, and for other purposes were reported, the total being $175,759.

The rocky coast of Maine and adjacent islands furnish immense quantities of granite rock of an excellent color and quality, and the convenient location of the deposits to navigable waters appealed long ago to the enterprising New England business men. The first successful attempt at quarrying in Maine is said to have been in 1825; and in 1836 and 1837 there was considerable activity in the stone industry of the state. In 1837 thirty acts of incorporation were granted by the legislature to quarry companies.[1]

The Vinalhaven quarries on Penobscot bay were first operated in 1850, and the product being well adapted for ornamental and building purposes has been extensively used all over the country. The quarries at Mt. Waldo, near Frankfort, were opened in 1853. The stone has been largely used in the building of forts on the coast, as well as for ornamental and other purposes, and has been shipped as far south as Mobile and New Orleans. In this section of the state are found some of the most extensive quarries in operation in the country. The granite for the United States Treasury building at Washington, D. C., was obtained from Dix island in Knox county. The Hallowell quarries in Kennebec county furnish one of the best working granites, and many prominent buildings and monuments have been constructed wholly or in part of this stone. Among these may be mentioned the New York state capitol at Albany, N. Y., the Maine state capitol at Augusta, the old Tombs prison, New York city, and the statue on the Pilgrims Monument at Plymouth, Mass. Many other localities are rich in deposits of siliceous crystalline rocks, and quarrying operations were reported during 1902 in 13 of the 16 counties of the state.[2]

Limestones and dolomites.—Limestone is abundant in Maine, especially in the southeastern part of the state. The entire product during 1902, reported from Knox county, was valued at $745,132, and was practically all burned into lime.[3] This stone is not commonly utilized for building, as its colors, blue and blue-black, veined with white, are poorly adapted for such purpose.[4]

The lime industry in Knox county dates back to the year 1733, when Samuel Waldo experimented upon the limestone of this locality, and, finding it of satisfactory quality, erected a kiln and prepared lime for the Boston market. The first cargo of lime shipped to New York was in 1823, and sold at $2 per cask. In 1888 the market price was about 97 cents per cask,[5] while in 1902 the price is reported at from 60 to 75 cents per barrel, when prepared for shipment.

Slate.—The production of slate is chiefly in Piscataquis county, although a small quantity has been reported near Waterville, in Kennebec county. The value of slate quarried in the state during 1902 was $206,558. Of the total quantity quarried, 26,468 squares, valued at $143,832, were used for roofing.[6]

Slate was discovered by Welsh farmers near Brownville, and a quarry in this vicinity was opened by A. H. Morrill as early as 1846. In 1870 slate quarrying began at Monson.[1] and these quarries are still the most important in the state. In color the slates are distinctively slate-blue to blue-black, resembling those of Pennsylvania. The best grades are generally of smooth homogeneous texture, strong, durable, handsome, and holding a uniform color on the roof.[2]

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[1] Stones for Building and Decoration, by George P. Merrill, pages 3 to 5.

[2] Stones for Building and Decoration, pages 58 to 66.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 698 and 699.

[4] Stones for Building and Decoration, page 309.

[5] Report on Industrial and Labor Statistics of Maine, 1889, pages 59 to 63.

[6] United States Geological Survey, "Mineral Resources of the United States," 1885, page 398.

All other minerals.—The feldspar obtained in Maine is considered the best in the United States. Feldspar quarrying near Auburn in Androscoggin county began in 1896. The spar occurs in pockets rather than in a continuous vein; the product obtained is pure and remarkably white.[3] The occurrence of this mineral is noted at other localities, quarrying being reported at Hebron, in Oxford county, and near Georgetown and Topsham, in Sagadahoc county, during 1902. The production of a considerable quantity of flint is reported with that of feldspar in Androscoggin and Sagadahoc counties.

No mining operations are reported for precious stones in the state of Maine, but a number of important finds were reported to dealers. Tourmaline and beryl of a considerable value were discovered during 1902 in Oxford county. In the same county two mica mines were reported during the year, but separate statistics can not be given without disclosing the operations of individual establishments.

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[1] Report on Industrial and Labor Statistics of Maine, 1889, page 72.

[2] The Mineral Industry, 1897, Vol. VI, pages 593 and 594.

[3] Ibid., 1898, Vol. VII, pages 261 and 266.

MARYLAND.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Maryland for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Siliceous crystalline rocks.	Limestones and dolomites.	Cement.	Slate.	Flint.	Iron ore.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	252	44	37	102	4	6	6	29	5	19
Number of operators	209	30	13	100	4	6	5	28	5	18
Salaried officials, clerks, etc.:										
Number	398	210	65	53	22	10	14	5	2	17
Salaries	$455,875	$315,791	$57,925	$31,299	$17,227	$4,720	$11,080	$1,910	$1,148	$14,775
Wage-earners:										
Average number	6,826	4,936	817	430	170	145	65	76	12	175
Wages	$4,323,939	$3,468,117	$425,372	$159,793	$71,677	$72,179	$21,883	$22,349	$5,294	$64,675
Contract work	$8,499	$8,499								
Miscellaneous expenses	$443,170	$312,198	$43,856	$20,841	$17,914	$5,523	$9,572	$12,314	$51	$20,901
Cost of supplies and materials	$859,735	$510,092	$107,135	$135,500	$51,879	$18,078	$8,627	$2,639	$1,152	$24,293
Value of product	$7,313,712	$5,579,869	$758,233	$453,030	$150,780	$118,084	$56,551	$46,911	$15,405	$134,979

[1] Includes operators as follows: Clay, 6; feldspar, 2 (3 mines); gold and silver, 1; infusorial earth, tripoli, and pumice, 1; marble, 2; mineral pigments, crude, 4; talc and soapstone, 2.

Coal mining is by far the most important mineral industry in the state, which ranked eleventh among the states in 1902 in the output of this mineral. The Cumberland coal field, which has been sending its high-grade steam coal into the market for nearly three-quarters of a century, and from which the entire coal product of Maryland is obtained, is the nearest to tide water of all the bituminous coal fields which supply the great coal markets of the northern Atlantic seaboard. The coal beds of the state are so situated as to yield a practically unlimited increase in production should the trade of the seaboard markets demand it.[1] Quarrying, with a product distributed, in the order of importance, among siliceous crystalline rocks, limestones and dolomites, and slate, constitutes also an important branch of the mineral industry of the state.

The minerals of known occurrence in the state, that were not commercially produced in 1902, are as follows: Asbestos, chrome, cobalt, copper ore, lead ores, graphite, gypsum, lignite, manganese, marl, molybdenum, nickel ores, quartz, serpentine, and zinc ores.

Development work during the year was confined to gold and silver and copper ore, with no return in product.

The relative importance of certain manufacturing industries of the state closely allied to, or based upon, the mining industry, since they use as their raw material the product of the mine and quarry, is shown in Table 2, as indicated by the value of their product.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$242,552,990
Based upon products of mines or quarries.		
Chemicals and allied products	$11,646,136	
Clay, glass, and stone products	5,110,578	
Iron and steel and their products	20,248,863	
Metals and metal products, other than iron and steel	33,174,693	
Miscellaneous industries	10,118,618	
		80,298,888
All other		162,254,102

The total value of the products of the manufacturing industries based on mining, as shown by Table 2, was $80,298,888, or 33.1 per cent of the total value of the product of all manufacturing industries in the state in 1900. During the same year there were employed in all branches of manufacture in the state 108,325 wage-earners, who received $38,748,551 in wages. In 1902 there were employed in the mines and quarries of the state 6,826 wage-earners, who received $4,323,939 in wages. Of the combined figures for these two branches of industry, therefore, 94.1 per cent of the wage-earners, receiving 89.9 per cent of the wages, were employed in manufacturing, while 5.9 per cent of the wage-earners, receiving 10.1 per cent of the wages, were employed in mining.

Table 3 shows the value of the annual production of the principal minerals of the state from 1890 to 1902.

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[1] United States Geological Survey, Sixteenth Annual Report, page 132 ff.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Siliceous crystalline rocks.	Limestones and dolomites.	Cement.	Slate.
1890	$2,899,572	$447,489	$164,960	$235,785	$110,008
1891	3,082,515	450,000	150,000	187,855	125,425
1892	3,063,580	450,000	200,000	[1] 220,991	116,500
1893	3,267,317	260,855	([2])	[1] 125,554	37,884
1894	2,687,270	308,966	350,000	[1] 136,000	153,068
1895	3,160,592	276,020	200,000	[1] 116,700	60,357
1896	3,299,928	251,109	264,278	[1] 125,175	72,142
1897	3,363,996	247,948	181,637	118,400	58,929
1898	3,532,257	317,258	433,658	118,989	82,240
1899	3,667,056	423,823	235,225	111,800	90,595
1900	3,927,381	488,822	317,207	131,028	128,673
1901	5,046,491	613,356	382,381	175,685	105,798
1902[3]	5,579,869	758,203	453,030	150,080	118,084

[1] Includes production from West Virginia.
[2] Not reported.
[3] Census figures.

Coal.—Some authorities place the discovery of coal in Maryland in the year 1801 at a point 6 miles northeast of Baltimore, and Benjamin Henfrey as the discoverer.[1] The first well authenticated discovery was made in 1804, at a point in Allegany county near the present site of Frostburg, by a Mr. Riser.[2] Various openings were made in the deposits from time to time, and they were worked on a small scale, chiefly for local use, for more than a quarter of a century. In 1830 the industry reached its second stage of development, when the first eastern shipment of coal was made from the old Neff mine. This first cargo was loaded at Cumberland and boated down the Potomac to Washington. For a decade or more the output of coal was confined to a very limited market, on account of the expensive and ineffective transportation facilities. The exceptional quality of Cumberland coal soon began to attract the attention of users at greater distances, and its mining, from the first shipment over the Baltimore and Ohio Railroad, in 1842, developed rapidly, and before long became the most important factor in the mineral industry of the state. The total shipments from the Cumberland region in this first year were 1,708 long tons. The annual output grew in the decade ending in 1852 to 334,178 long tons, and in 1860 it had increased to 788,909 long tons. During the earlier years of the Civil War the industry suffered a slight decline, but recovered in 1863, and at the end of the next decade, in 1872, the output exceeded 2,000,000 tons. The output remained at about this figure during the next ten years. The general industrial activity of the decade from 1882 to 1892 was shared by the coal mining industry in the Cumberland region, and the production again increased rapidly, reaching its maximum in 1891, when the state's output was 3,831,251 short tons.[3]

Table 4 shows the annual coal production, in short tons, from 1842 to 1902:

TABLE 4.—*Annual production of coal, bituminous: 1842 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1842	2,101	1863	877,313	1883	2,476,075
1843	12,421	1864	735,764	1884	2,765,617
1844	18,545	1865	1,025,208	1885	2,833,337
1845	30,572	1866	1,217,668	1886	2,517,577
1846	36,707	1867	1,381,429	1887	3,278,023
1847	65,222	1868	1,529,879	1888	3,479,470
1848	98,032	1869	2,216,300	1889	2,939,715
1849	175,497	1870	2,095,760	1890	3,357,813
1850	242,517	1871	2,670,338	1891	3,831,251
1851	317,460	1872	2,647,156	1892	3,419,962
1852	411,707	1873	3,198,911	1893	3,716,041
1853	657,862	1874	2,899,392	1894	3,501,428
1854	812,727	1875	2,808,018	1895	3,915,585
1855	735,137	1876	2,126,873	1896	4,143,936
1856	817,659	1877	1,939,575	1897	4,442,128
1857	654,017	1878	2,068,925	1898	4,674,884
1858	722,688	1879	2,132,233	1899	4,807,396
1859	833,349	1880	2,549,731	1900	4,024,688
1860	907,177	1881	2,677,378	1901	5,113,127
1861	287,078	1882	1,555,445	1902	5,271,609
1862	346,201				

The coal deposits of the state are confined to western Allegany and Garrett counties and form a part of a long, narrow, detached coal field, lying on the extreme fringe of the great Appalachian coal basin. This wedge shaped strip, beginning just north of the Pennsylvania line and extending across Maryland into West Virginia, is known as the "Cumberland field." In some respects it is one of the most important in the United States.[3]

Maryland's share of these economic coal deposits is known by various names, among which are the "Frostburg basin" and the "Georges Creek basin." It is situated in an elevated trough to the west of the town of Cumberland, between two parallel ridges, known as Davis and Savage mountains, which are less than 4 miles apart. There are five workable coal seams, ranging in thickness from 14 feet in the "Big Vein" down to 3 feet in the vein of the Bayou formation.[4] The bulk of the state's coal production is mined in Allegany county, though the number and extent of workable seams in Garrett county afford much promise for future exploitation there.

The state's coal product comprises two distinct classes or varieties. That known as bituminous contains a high proportion of volatile gases and less than 70 per cent of carbon, and is especially valuable for the manufacture of coke and gas. This variety is not extensively mined at present. The other class, known as semibituminous, has no superior as a steam coal, and constitutes the bulk of the output of the mines of the state.

Siliceous crystalline rocks.—Granite quarrying in the state began in Cecil county in 1816.[5] During 1816 and 1817 a bridge was built across the Susquehanna river at the present site of Port Deposit. Stone for the construction of abutments was quarried near the present site of the extensive McClenahan quarries in Cecil county. The exceptional qualities of the stone soon came to be recognized, and after the completion of the bridge, further and extensive exploitation of the granite in the vicinity was carried on. A very important industry has flourished there since. The Port Deposit granite is of a gneissoid character, light bluish gray in color, and eminently strong and durable.[1]

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[1] Iron in All Ages, by James M. Swank, page 470.
[2] Maryland Geological Survey, Allegany county, page 167.
[3] United States Geological Survey, Sixteenth Annual Report, page 132 ff.
[4] Geological Survey of Maryland, Vol. I, page 219 ff.
[5] Geological Survey of Maryland, Cecil county, page 196 ff.

The occurrence of granite and gneissoid rocks in the state is confined within the area known as the Piedmont plateau, a broad belt extending from Cecil and Harford counties on the northeast to Montgomery county and the Potomac river on the southwest. Within this area is an abundance of excellent building material, though quarry development has not yet been rapid. In the vicinity of Ellicott City occurs a dark gray granite which is rendered porphyritic by the presence of ill-defined crystals of pink feldspar. This has been quarried since an early period in the state's history and has been extensively used for building purposes, especially in Baltimore. One of the best granites in the state for most of the uses which granite serves occurs within a small area in the southwestern corner of Baltimore county, near Woodstock. This rock has been extensively quarried with few interruptions since 1832–33. Among the many important buildings in the construction of which it has been used as material are the Capitol, Patent Office, old Post Office, and Library of Congress in Washington.[2] The stone is of medium texture and of dark gray color. Another granite which is remarkably free from defects, and which is well adapted to monumental as well as to general structural purposes, is found near Guilford, in Howard county. This stone is of moderately fine and uniform grain and of a light gray color. Large quantities of dark gray gneiss for local use in rough building work is quarried in the immediate vicinity of Baltimore.[3]

Limestones and dolomites.—Of the carbonate of lime deposits in the state, the limestones, as distinguished from the marbles, occur generally throughout the western part, or the Appalachian region, and in the form of limestone conglomerate or "Potomac marble" in the Frederick valley.

The blue limestones are in demand locally for building purposes. On weathering, this stone changes its color rapidly. The limestone of the Frederick valley is known as "calico rock" or "Potomac marble" and was used for the columns in the construction of the old Hall of Representatives in Washington. A good exposure of this rock is at Washington Junction, and its occurrence extends northward along the base of the Catoctin mountains.[4] Buckeystown, in Frederick county; Cockeysville, in Baltimore county, and Baltimore have long been important points in the manufacture of lime.[5]

Cement.—The industry of hydraulic cement manufacture is one of considerable relative importance in the state. The greater part of the state's output comes from the limestones in the vicinity of Cumberland and Hancock and from the Shenandoah limestones of the Hagerstown valley near Sharpsburg. The cement produced is of excellent quality, and the demand for it extends beyond the state.[6] The following table shows the annual production of cement since 1890:

TABLE 5.—*Annual production of cement: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1890	223,209	1897	296,000
1891	294,900	1898	297,475
1892	[1] 252,092	1899	362,000
1893	[1] 231,590	1900	335,070
1894	[1] 279,000	1901	351,329
1895	[1] 242,000	1902	409,200
1896	[1] 271,500		

[1] Includes production from West Virginia.

Slate.—Since Revolutionary times the slate deposits of the Peach Bottom region in Harford county have been worked for a roofing material, and the exceptional quality of these slates is strongly evidenced by the fact that after a hundred years' exposure they show almost no change. The area in which they occur is a narrow zone beginning near Pylesville, on the Baltimore and Lehigh Railway, and running into York and Lancaster counties, Pennsylvania.[7]

Flint.—Maryland is a very important contributor to the aggregate output of flint and quartz, commercially known as flint in the United States. In 1902, 6 of the 19 active quarries in the United States were located within the state, and 49.2 per cent, or about one-half of the output of ground flint in the country came from these quarries. Important centers for the production of flint and quartz are Darlington and Conowingo.[8]

Iron ores.—The iron industry in Maryland, whose development began in the early days of the colonial period, was for more than a century one of the most important factors in the prosperity of the state. The first recorded notice taken of the iron ores of Maryland and Virginia by the early settlers was in 1608, when Capt. John Smith sent 2 barrels of iron ore specimens to England for examination. Nothing is known of the result of this examination. About one hundred years later the first recorded operations were inaugurated by some Welsh miners in the vicinity of Iron Hill and Elkton. The extent of these operations is not known, but in the development of the iron ores of this same region in the nineteenth century, "the miners employed in the ore pit on Iron Hill came upon one of the galleries made by the Welsh miners and discovered a rude shovel and pick and a small tallow candle, the wick of which was made of flaxen yarn. The candle, though probably a century old, was in a good state of preservation, but the shovel and pick were so badly rusted that the former could be readily picked to pieces with the thumb and finger."[1]

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[1] Stones for Building and Decoration, by George P. Merrill, page 66 ff.

[2] Geological Survey of Maryland, Vol. I, page 206 ff.

[3] Stones for Building and Decoration, page 67 ff.

[4] Geological Survey of Maryland, Vol. I, page 209 ff.

[5] The United States Geological Survey, "Mineral Resources of the United States," 1887, page 533.

[6] Geological Survey of Maryland, Vol. I, page 213 ff.

[7] Ibid., page 211.

[8] United States Geological Survey, Seventeenth Annual Report, pages 838 and 846.

The first iron works in Maryland were probably erected in Cecil county at the head of Chesapeake bay. It is probable, also, that the bloomery built at North East, on North East river, before 1716 formed the pioneer iron enterprise of that character. Scrivenor, in his "History of the Iron Trade," published in 1841, says that in 1718 Maryland and Virginia exported "3 tons and 7 cwt." of bar iron to England, and, since Virginia had no forges at that date, the shipment must have come from the works of Maryland.

The era of systematic iron production in the state was opened by the organization in 1722 of the Principio Company, which in that year began the construction of a furnace at the mouth of Principio creek. Shortly after the organization of the company Mr. John England, of Bristol, England, who proved to be one of the most intelligent, enterprising, and successful of the early American ironmasters, became its general manager. He built the first furnace and the first forge in the state. The enterprise grew rapidly and soon its production of iron had reached a scale of commercial importance. About 1725 Augustine and Lawrence Washington, the father and half-brother of the first President,[2] became interested in the company, which soon outranked all others in the manufacture of pig and bar iron from its three furnaces and two forges in Maryland and one furnace in Virginia. For fifty years it was the most important of colonial iron enterprises, contributing one-half to the total exports of pig iron from the colonies to England up to the Revolution.[3] The marked success of this company brought others into the field for the exploitation of the iron deposits of the state, and by 1761 the industry had attained a flourishing condition. This is indicated in a report made by the governor to the effect that there were 18 furnaces and 10 forges in the state which made 2,500 tons of pig iron a year.[4] During the middle and latter part of the eighteenth century and the early part of the nineteenth, the industry of iron manufacture spread to other sections of the state and many furnaces were built, but nearly all of these were later abandoned. One of the most notable of these was the Catoctin furnace at Frederick, which was built in 1774, and furnished guns and projectiles to the Continental Army during the Revolution.

In recent years several modern furnaces have been built in the vicinity of Baltimore. By far the largest of these is at Sparrows Point, which plant, however, uses only ores obtained from sources outside the state.

Since the discovery of extensive deposits of higher grade ores in other sections of the country, notably in Michigan, Pennsylvania, and Alabama, the industry of iron ore mining in the state has rapidly declined until now the great iron using industries of the state depend to only an inconsiderable extent upon local ores.[5]

Sandstones and quartzites.—The quarrying of sandstones and quartzites in the state has continued in a more or less systematic way from the building of the old Potomac canal around the Great Falls of the Potomac, in 1774, when Seneca sandstone was used in the construction of two locks, down to the present time. This red Seneca sandstone has long been highly regarded alike for its durability, for the ease with which it can be worked, and for its beautiful colors. It entered largely into the construction of the Smithsonian Institution at Washington. Other occurrences of sandstone that have been exploited, and for which there is a greater or less demand, are in Harford county in the Catoctin and Blue Ridge mountains, and in Allegany county.

All other minerals.—Another factor of the mineral wealth of Maryland is found in the clay deposits, which are widely distributed and in many cases possess characteristics that render them of exceptional economic importance.

The first plant constructed in the United States for the manufacture of fire brick was that built in 1841 at Mt. Savage in Allegany county. The main fire clay deposits of the state lie near the bottom of the Coal Measures, the beds ranging from 8 to 20 feet in thickness. Their exploitation has been a characteristic industry of the state for more than fifty years, and the brick made from them are considered the best in the country. The clay deposits of the state that are most extensively exploited at present are those comprised in the Columbia and Patapsco formations. The center of their manufacture into terra cotta work and pottery is Baltimore.[6] The kaolin deposits of Cecil county, which are a continuation of the Delaware deposits, have been extensively mined for use in the manufacture of white ware for many years.[7]

Feldspar occurs at a number of places in the state, but was produced commercially in 1902 from only three mines located in Baltimore, Cecil, and Harford counties.

The discovery of gold occurred in Maryland in 1849, near Sandy Spring, in Montgomery county, and most of the mines subsequently opened lie along the southern boundary of this county in the vicinity of the Great Falls of the Potomac. The known occurrences of gold in the state are confined to the Piedmont plateau, and are in quartz veins. Some very rich specimens have been found in this region, but the deposits of the metal are not sufficiently even to render its mining profitable.[1]

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[1] Maryland Geological Survey, Cecil county, page 218 ff.

[2] Maryland Geological Survey, Vol. I, page 45 ff.

[3] Iron in All Ages, page 240 ff.

[4] Maryland Geological Survey, Vol. I, page 50.

[5] Maryland Geological Survey, Vol. I, page 218 ff.

[6] Ibid., page 214 ff.

[7] Maryland Geological Survey, Cecil county, page 211 ff.

Infusorial earth has been produced in greater quantities in Maryland than in any other state in the country. The deposits occur at the base of the Chesapeake formation, and in parts of Calvert and Charles counties attain a thickness of 30 or 40 feet. The beds have been extensively worked in the vicinity of the mouth of Lyon's creek on the Patuxent river and at Pope's creek on the Potomac.[2]

The industry of marble quarrying in the state dates probably from 1815, when material for use in the Washington Monument at Baltimore was taken from the deposits at Cockeysville in Baltimore county. This point continues to be the important marble producing center of the state. The 26-foot monoliths in the National Capitol were taken in 1859-61 from what is now known as the Beaver Dam quarry. Though there are numerous occurrences of marble deposits, those which have been developed sufficiently to demonstrate their economic importance are limited to what is known as the Green Spring valley, extending east and west at a distance of from 12 to 20 miles north of Baltimore. In this belt are located the two quarries mentioned. The stone is a white dolomite of medium texture, strong and durable. Small lenses of compact crystalline marble occur in Carroll and Frederick counties. Also at Texas occurs a coarsely crystalline white limestone, sometimes known as alum marble, which is extensively quarried, mainly for quicklime and flux, though it was used in constructing the lower 150 feet of the Washington Monument in Washington.[3]

Ores from which mineral paints are made are of quite common occurrence in the state and have been worked at many points. In former years large quantities were obtained from the brown ore deposits in Frederick county and also in Carroll and Harford counties. The Patapsco formation in Anne Arundel and Prince George counties carries easily worked deposits of a fine and highly ferruginous clay. This belt at present is the principal seat of the industry of mineral pigment production in the state.[2]

Soapstone occurs in several counties, especially Carroll, Harford, and Montgomery, where it has been mined at various times. The most extensive deposits are in Carroll county, in a northwesterly direction from Marriottsville.[4]

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[1] Maryland Geological Survey, Vol. I, page 221 ff.

[2] Ibid., page 222.

[3] Stones for Building and Decoration, page 213 ff.

[4] Maryland Geological Survey, Vol. I, page 227.

MASSACHUSETTS.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Massachusetts for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Siliceous crystalline rocks.	Sandstones and quartzites.	Limestones and dolomites.	Marble.	All other minerals.[1]
Number of mines or quarries	251	204	19	11	8	9
Number of operators	234	194	15	8	8	9
Salaried officials, clerks, etc.:						
Number	360	279	35	17	13	16
Salaries	$309,978	$248,512	$25,536	$12,606	$12,468	$10,856
Wage-earners:						
Average number	4,242	3,395	342	203	130	172
Wages	$2,525,405	$2,015,340	$222,977	$99,740	$72,730	$84,618
Contract work	$1,853					$1,853
Miscellaneous expenses	$273,791	$211,715	$35,440	$10,192	$7,837	$8,577
Cost of supplies and materials	$762,335	$509,702	$59,486	$133,609	$18,324	$41,214
Value of product	$4,671,855	$3,451,397	$487,366	$339,349	$165,489	$228,254

[1] Includes operators as follows: Asbestos, 1; clay, 1; corundum and emery, 1; feldspar (operator reported under flint); flint, 1; graphite, 1; infusorial earth, tripoli, and pumice, 1; iron ore, 1; sulphur and pyrite, 1; talc and soapstone, 1.

The principal mineral industry of Massachusetts is quarrying, and as shown in Table 1, the value of siliceous crystalline rocks quarried in 1902 represents 73.9 per cent, or nearly three-fourths of the entire mineral production of the state. Massachusetts granite was the first to be systematically produced in the United States, and the state continues to lead in that production.[1] Sandstone, limestone, and marble are also quarried in considerable quantities, and the statistics for these operations are given separately in the table.

Among the minerals listed in the group of "all other minerals" are two of great importance. More than half of the emery produced in the United States is mined by one operator in Massachusetts, and a large proportion of the sulphur and pyrite production is also contributed by this state. Although these are of great importance, the statistics can not be shown separately because to do so would disclose the reports of individual operators.

A number of minerals for which no commercial production was reported in 1902 are known to occur in the state. Among these the following may be mentioned: Barytes, which occurs chiefly as gangue, with lead and copper, in Hampshire and Franklin counties; a very hard anthracite coal in Bristol, Plymouth, and Norfolk counties, which can not be mined profitably; chalcopyrite found in pyrite vein in Franklin county;[2] fuller's earth and garnet found in Worcester county, and garnet also in Framingham, Middlesex county; native gold found in small quantities in Middlesex, Norfolk, and Plymouth counties; deposits of stone suitable for use as millstones or whetstones in Hampshire, Norfolk, and Berkshire counties; lead ore found in Essex, Hampshire, Middlesex, and Worcester counties; manganese in small beds in Hampshire, Berkshire, and Franklin counties; ocher in Berkshire and Worcester counties; amber, agate, amethyst, beryl, jasper, jade, smoky quartz, and topaz are precious stones that have been reported in the state; quartz sand found in Berkshire, Essex, and Franklin counties; quarries of slate for local use, operated in Worcester and Middlesex counties; sphalerite or zinc blende occurring with galena in Franklin and Hampshire counties and at the Newburyport lead mines in Essex county, where operations were carried on before 1878.[3]

The relative importance of manufacturing industries closely allied to, or based upon the mining industry, using as their raw material the product of the mine or quarry, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.		Value of product
All manufactures		$1,035,198,989
Based upon products of mines or quarries		
Chemicals and allied products	$9,091,102	
Clay, glass, and stone products	12,703,947	
Iron and steel and their products	67,735,843	
Metals and metal products, other than iron and steel	22,232,650	
Miscellaneous industries	51,107,117	
		196,930,979
All other		838,268,010

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[1] Stones for Building and Decoration, by George P. Merrill, pages 2 and 3.

[2] The United States Geological Survey, "Mineral Resources of the United States," 1887, pages 742 to 744.

[3] The United States Geological Survey, "Mineral Resources of the United States," 1887, page 745.

From the foregoing table it will be seen that 19 per cent of the total manufactured product of the state was based primarily upon the products of mines and quarries. The total product of manufactures as reported at the census of 1900 was $1,035,198,989; there were employed 497,448 wage-earners, who received $228,240,442 in wages. The product of mines and quarries in the state during 1902 was valued at $4,671,855, and there were reported as engaged in this production 4,242 wage-earners, to whom was paid the sum of $2,525,405 in wages.

Therefore the value of the product of mines and quarries was but four-tenths of 1 per cent of the combined product of mineral and manufacturing industries, 99.6 per cent of the total being contributed by manufactures. There were engaged in mining and quarrying eight-tenths of 1 per cent of the total number of wage-earners, and these received 1.1 per cent of the total wages. The manufacturing industries employed 99.2 per cent of the total wage-earners, and paid 98.9 per cent of the total wages.

The following table shows the value of the annual production of the principal minerals of the state from 1890 to 1902, inclusive:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Siliceous crystalline rocks.	Sandstones and quartzites.	Limestones and dolomites.	Marble.
1890	$2,503,593	$649,097	$119,978	(1)
1891	2,600,000	400,000	100,000	(1)
1892	2,200,000	100,000	200,000	$100,000
1893	1,631,204	223,348	156,528	(1)
1894	1,925,830	160,231	195,982	(1)
1895	1,918,894	339,487	75,000	2,000
1896	1,656,978	304,304	118,622	83,904
1897	1,735,069	191,684	126,508	79,721
1898	1,650,568	91,287	171,822	38,240
1899	1,798,294	151,877	168,147	50,416
1900	1,698,035	153,427	209,359	130,735
1901	2,216,258	247,310	241,098	126,516
1902 [2]	3,451,397	487,326	339,349	165,180

[1] Not reported. [2] Census figures.

The production of 1902, according to Table 3, increased over that of 1901 in all the industries presented. The production of siliceous crystalline rocks, as well as that of limestones and dolomites, during 1902 was greater than that reported during any year of the thirteen years shown in the table.

Siliceous crystalline rocks.—The Massachusetts production of siliceous crystalline rocks during 1902 was valued at $3,451,397, which is greater than the amount reported for any other state in the Union. Thirty-nine per cent of this value, or $1,347,214, was used for dressed stone for building and monumental work; 27.1 per cent, or $936,413, was for stone sold in the rough, and the remainder was for paving purposes, crushed stone, riprap, etc., in the order named.

In a strictly scientific sense, most of the siliceous crystalline rocks of Massachusetts are not granites, but granitites or gneisses.

The granitites differ from granite proper in the absence of white mica, while gneisses are crystalline rocks which possess a more or less well-marked banding, usually due to the arrangement of the micas in defined planes.[1]

Although granite bowlders were used in construction as early as 1650,[2] it was not until the early part of the nineteenth century that quarrying was prosecuted to any considerable extent in Massachusetts. In 1810 the Boston court-house, in 1814 the New South church, and in 1818–19 the first stone block in Boston were constructed of stone introduced by canal from Chelmsford, 30 miles distant. The quarries of Quincy, in Norfolk county, were opened about 1820, and the history of systematic siliceous crystalline rock quarrying in New England begins at this time.[3]

The stone obtained from this locality is coarse grained and very hard and in color generally a dark blue-gray. It is classed as a hornblende pyroxene, and although the brittle pyroxene makes the production of a perfect surface somewhat difficult, it is still used extensively for finished as well as for rough work. Its suitability for interior decoration may be seen in the polished stairways and pillars of the Philadelphia city buildings. The Quincy stone was first brought into prominence in 1825 through its use in the construction of the famous Bunker Hill Monument at Charlestown, and what is claimed to be one of the first railroads in the United States was built a distance of 3 miles from these granite quarries to the Neponset river in 1826.[4]

Probably the Gloucester quarries at Bay View, in Essex county, were the next to be worked, being opened in 1824. The rock obtained is hornblendic with considerable black mica or annite, coarse in texture, and greenish or gray in color. It is hard and tough, and being very durable, it is eminently suitable for building and ornamental work. A number of other quarrying localities were opened in Essex county, chiefly at Rockport in 1830. The stone quarried resembles the Gloucester type and may be obtained in massive blocks.[5] The stone quarried at Chester, Hampden county, is clear gray or bluish gray of medium shade; it is homogeneous and of fine, even grain.[6]

At Dedham, Norfolk county, there is produced an epidote granite of fine grain and light pink, tinged with green, in color, and at Brockton, Milford, and North Easton a light pink variety of coarse biotite is quarried.

The stone obtained at Milford, Worcester county, possesses a more or less plainly marked banding, which increases its beauty without any depreciation of its strength or usefulness. At Monson, Hampden county, a characteristic gneiss is quarried and in a number of other localities siliceous crystalline rocks may be found.[1] Quarrying operations have proved very successful in Massachusetts, as the largest deposits are adjacent to navigable water, which renders shipment convenient and comparatively inexpensive.

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[1] The Mineral Industry, 1898, Vol. VII, page 637.
[2] Stones for Building and Decoration, pages 1 and 2.
[3] One Hundred Years of American Commerce, Vol. 1, page 189.
[4] Harper's Encyclopedia, Vol. IX, page 404.
[5] Stones for Building and Decoration, pages 68 to 72.
[6] United States Geological Survey, Eighteenth Annual Report, page 965.

Sandstones and quartzites.—The sandstone and quartzite production of Massachusetts during 1902 was valued at $487,366. More than one-half of the amount quarried was used in roadmaking and the rest, with the exception of a small amount reported as rubble, was sold principally in the rough or dressed condition for building purposes. In the vicinity of East Longmeadow, Hampden county, are found the principal sandstone quarries, and some of the earliest quarrying operations have been reported in this locality. Sandstone of several colors, fine grained and of a massive type, is obtained, and is used chiefly for building purposes.[2] Geologically speaking, this sandstone locality is a northward continuation of the Connecticut brownstone deposit, extending into Massachusetts as far north as Northampton. This stone is of a Triassic variety and is soft and easily worked.[3]

A number of quarries in and about Boston, principally municipal in ownership, yield a so-called pudding stone; this is a rough and durable stone suitable for roadmaking, concrete, etc., but generally too coarse for ornamental work.[3] These conglomerates in Roxbury, Suffolk county, came into use about 1840, and have been utilized somewhat in building construction and for the rustic masonry work of the Boston system of parkways.

Limestones and dolomites.—Massachusetts limestones and dolomites are obtained entirely in Berkshire county; the production during 1902 was valued at $339,349. They occupy a belt along the Housatonic river and are of the same age as those of Rutland valley, Vt., to which stones they bear a close resemblance.[4]

Marble.—The production of marble in Massachusetts for 1902 was valued at $165,489 and quarrying operations were chiefly reported in Berkshire county. In composition the marble ranges from marble proper to dolomites, or to varieties carrying a high percentage of magnesium carbonate.[2] At Egremont quarries was obtained the marble for the Corinthian columns of Girard College in Philadelphia about 1835. In 1838 the Sheffield, and in 1852 the Lee quarries were opened. Stone from the latter was used in the extension of the Capitol at Washington, D. C. The marbles are all white or gray, of medium fine grained texture, and are better adapted for building than for decoration. They often contain white tremolite crystals which weather out on exposure, leaving the rock with a rough pitted surface, as may be noticed in the exterior walls of the Capitol, where this marble has been used.[5]

All other minerals.—A small quantity of asbestos was found associated with the talc produced in the state in 1902.

A fire clay was mined near Gay Head, in Dukes county. It generally burns to a white or cream, except the red variety, which burns blue, and upon application of greater heat changes to an iron brown.

Emery was discovered in Chester, Hampden county, in 1864; two years later corundum crystals were also found, and soon thereafter began the first actual mining of emery and corundum in America. In 1902 most of the emery produced in the United States came from this locality. In 1871 the occurrence of corundum in vermiculites with asbestos in olivine rocks, and very similar to the south Appalachian deposit, was discovered at Pelham.[6]

Flint and feldspar were both obtained from a quarry near Huntington, in Hampden county, and the product obtained is ground and screened before being placed on the market. Flint is the principal stone quarried, and in 1902 nearly one-tenth of the total production of the United States was reported from Massachusetts.

A small amount of graphite was mined during 1902, near Sturbridge, in Worcester county. An infusorial earth was mined in Middlesex county.

Iron ore was discovered near Lynn soon after its settlement in 1629, and in 1643 the first iron foundry established in America was located at what is now Saugus Center, in the vicinity of Lynn. This locality furnished most of the iron used in the colony prior to 1671 and the mines were operated at intervals after that time until 1688 when they seem to have been abandoned. The second iron enterprise undertaken in New England was at Braintree, about 10 miles south of Boston. Iron ore was mined there in the early part of 1652,[7] but operations were suspended in the following year on account of the scarcity of ore. Massachusetts was the chief iron center of the continent for a hundred years after its settlement in 1620. During this time bog ore was mined, mostly in the eastern counties. The rich brown hematite ores of western Massachusetts were developed in 1750 and the first furnace was built at Lenox, in Berkshire county, in 1765.[8] This county was the only producer of iron ore in the state during 1902.

The only pyrite mines in Massachusetts are located in Franklin county and were opened in June, 1882. The mineral is an almost pure iron pyrite and the width and continuity of the ore vein, as well as its great length, depth, and purity, make it one of the most remarkable deposits ever known.[9]

Talc is mined in Berkshire county in the vicinity of Dalton. About one-half the product is used by foundries and the balance is prepared as talcum powder or is used as an ingredient of paint.

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[1] Stones for Building and Decoration, pages 68 to 72.

[2] The Mineral Industry, 1898, Vol. VII, page 639.

[3] Stones for Building and Decoration, page 143.

[4] The Mineral Industry, 1898, Vol. VII, pages 639 and 640.

[5] Stones for Building and Decoration, page 215.

[6] Transactions of the American Institute of Mining Engineers, Vol. XXV, page 857.

[7] Iron in All Ages, by James M. Swank, pages 108 to 113.

[8] Ibid., pages 120 to 122.

[9] United States Geological Survey, "Mineral Resources of the United States," 1885, page 503.

MICHIGAN.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Michigan for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Iron ore.	Copper ore.	Cement	Coal, bituminous.	Limestones and dolomites	Gypsum.	All other minerals[1]
Number of mines, quarries, and wells	203	80	20	11	31	30	6	25
Number of operators	146	41	20	10	30	29	4	12
Salaried officials, clerks, etc.:								
Number	1,585	760	409	102	99	62	127	26
Salaries	$1,840,132	$775,914	$508,076	$131,131	$87,780	$49,264	$171,245	$26,722
Wage-earners:								
Average number	31,901	11,456	13,887	938	1,145	665	359	201
Wages	$20,101,616	$9,132,763	$8,741,992	$535,570	$1,075,805	$325,379	$176,607	$112,600
Contract work	$77,047	$57,382	$11,725		$7,500			$440
Miscellaneous expenses	$3,869,061	$3,004,384	$473,501	$170,477	$106,411	$36,164	$44,715	$33,506
Cost of supplies and materials	$9,351,409	$3,661,194	$4,688,419	$704,237	$92,448	$89,689	$88,634	$26,788
Value of product	$50,157,358	$26,690,860	$18,247,207	$2,134,396	$1,658,192	$657,072	$459,621	$310,010

[1] Includes operators as follows: Clay, 1; graphite, 2; petroleum, 1 (13 wells); sandstones and quartzites, 8 (9 quarries); sandstones and quartzites includes all data for grindstones and pulpstones and for oilstones, whetstones, and scythestones.

The mineral resources of Michigan are extensive and varied. The iron ore deposits of the Upper Peninsula along the shores of Lake Superior are extensive, and the annual production is enormous. The copper mines of the state are among the richest in the world, and the celebrated Calumet and Hecla mine is claimed to be the most profitable copper mine known. Although coal underlies some 6,700 square miles of the state's area, it is of inferior quality and not pure enough for smelting purposes. The Huron grindstones have been quarried for many years, and Michigan ranks second in their production in the United States, Ohio being first. Valuable deposits of gypsum occur, which, in the vicinity of Grand Rapids and Alabaster, are extensively quarried and used in the manufacture of stucco. The Lake Superior region also produces gold, silver, agate, sardonyx, chalcedony, cornelian, jasper, and opals, as well as roofing slate, freestone, marble, and limestone.[1] Among other minerals to be found are fire clay, marble, ochers, freestones, slates, limestones, and glass sand.[2]

In addition to the minerals mentioned in the foregoing table, the following minerals found in Michigan were not produced in commercial quantities in 1902: Amethysts, barytes, copper pyrites, gold, granite, manganese ores, ocher, serpentine rock, slate, and strontium ore.

The 17 operators who reported active mines and quarries with no production in 1902 were engaged principally in developing copper and iron deposits. These operators employed during the year an average of 353 wage-earners and paid $222,215 in wages; the salaried officials, clerks, etc., received $69,967; the miscellaneous expenses amounted to $103,887, and the cost of supplies and materials to $201,656.

The value of the products of the manufacturing industries of the state, based primarily upon minerals mined or quarried, as reported at the census of 1900, is shown in the following table, which also shows the total value of the products of all manufactures in Michigan for the same year:

TABLE 2.—*Manufactures based primarily on the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$356,944,082
Based upon products of mines or quarries:		
Chemicals and allied products	$7,291,387	
Clay, glass, and stone products	4,525,273	
Iron and steel and their products	34,071,223	
Metals and metal products, other than iron and steel	25,266,939	
Miscellaneous industries	12,576,108	
		83,730,930
All other		273,213,152

From the above table it will be seen that the total value of the products of manufactures in Michigan, based primarily upon minerals mined or quarried, was $83,730,930, or 23.5 per cent of the total. The total value of the output of the mines, quarries, and wells in 1902 was $50,157,358, or 12.8 per cent of the total value of the product of all manufacturing and mining industries.

The average number of wage-earners engaged in the manufacturing industries in 1900 was 162,355, and the total wages paid amounted to $66,467,867. The average number engaged in mining in 1902 was 31,951, and their total wages amounted to $20,103,616. The total number of wage-earners, therefore, employed in mining and manufacturing industries was 194,306, and they received in wages $86,571,483. Of this total, manufactures employed 83.6 per cent of the wage-earners and paid 76.8 per cent of the wages. The wage-earners employed in mining industries constituted 16.4 per cent of the total number employed and received 23.2 per cent of the total wages paid.

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[1] King's Handbook of the United States, pages 410 and 411.

[2] Ibid., page 407.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals in Michigan from 1890 to 1902, except copper ore, values for which can not be obtained.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Iron ore.	Cement.	Coal, bituminous.	Limestone and dolomites.	Gypsum.
1890	(1)	(1)	$149,185	$85,952	$192,099
1891	(1)	(1)	133,397	75,000	223,725
1892	$16,587,521	(1)	121,314	95,000	306,727
1893	8,611,192	(1)	82,462	58,282	303,921
1894	5,844,995	(1)	103,049	336,287	189,620
1895	8,403,958	(1)	180,016	424,589	171,007
1896	10,143,918	$87,000	150,631	109,427	116,124
1897	8,347,015	26,250	325,416	215,177	193,576
1898	10,368,807	134,750	462,711	271,523	204,310
1899	13,707,899	513,849	870,152	371,210	283,537
1900	28,859,650	830,940	1,259,683	425,636	285,119
1901	21,735,592	1,128,290	1,753,064	565,931	267,213
1902[2]	26,626,860	2,134,396	1,653,192	657,072	459,421

[1] Not reported separately. [2] Census figures.

Iron ore.—The existence of iron ore deposits on the southern border of Lake Superior was known to white Indian traders as early as 1830. Their commercial value, however, was not realized until 1844. In 1845 the celebrated Jackson mine in the Marquette district was located and the first forge was built. The first iron was made in this region during the following year.[1] The first iron ore shipped from the Marquette mines for commercial purposes was in 1853, and since that time there has been a steady increase in the output. In 1877 the first shipment of ore was made from the Menominee district and in 1884 from the Gogebic district. The yearly production of the Michigan iron ore mines has increased from 948,553 long tons in 1872 to 11,135,215 tons in 1902. From 1890 to 1900 Michigan ranked first among the iron ore producing states, but since that time it has ranked second, Minnesota being first. By far the greatest quantity of Michigan iron ore is of the red hematite variety, although magnetite is produced to some extent.

The following table, compiled from the reports of the United States Geological Survey, shows the practically steady increase in the iron ore production in this state from 1854 to the present time:

TABLE 4.—*Annual production of iron ore: 1854 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.	YEAR.	Long tons.
Previous to 1854	75,083	1870	859,507	1887	3,934,339
1854	3,000	1871	813,984	1888	4,113,803
1855	1,449	1872	948,553	1889	5,856,169
1856	6,790	1873	1,195,234	1890	7,141,656
1857	25,646	1874	899,934	1891	6,127,001
1858	22,876	1875	881,166	1892	7,543,544
1859	68,832	1876	993,311	1893	4,668,324
1860	114,410	1877	1,025,129	1894	4,419,074
1861	49,909	1878	1,127,593	1895	5,812,444
1862	124,169	1879	1,420,745	1896	5,706,736
1863	203,055	1880	1,948,334	1897	6,067,463
1864	247,059	1881	2,125,729	1898	7,346,846
1865	193,758	1882	2,656,933	1899	9,146,157
1866	296,713	1883	2,518,048	1900	9,926,727
1867	565,504	1884	2,225,146	1901	9,654,067
1868	510,522	1885	2,205,190	1902	11,135,215
1869	639,097	1886	3,179,511		

Copper ore.—The existence of native copper on the southern shore of Lake Superior was first made known by the Jesuit missionaries early in the seventeenth century. Other explorers found copper in that locality in the succeeding century, and in 1770 Capt. Jonathan Carver, of London, published a book, telling of the rich deposits of copper in the Lake Superior region. This led to the formation of a copper mining company in London. During the winter of 1771-72, this company sent over from England a party of miners who conducted operations along the Ontonagon river. The attempt failed, however, and nothing further was done at copper mining for seventy years.[2]

Throughout the entire copper region numerous excavations have been found. It is believed these were made at a very remote period, for the purpose of securing copper. Some of this mine work is on an extensive scale, attaining, in one instance, a depth of 50 feet in the solid rock.[3]

The formation carrying the cupriferous lodes and veins of the Lake Superior district is composed of old lava flows, supplemented by beds of conglomerate which have been formed by the deposition of rocks, broken from adjacent shores, upon old sea beds. This belt of rocks, named after the Keweenaw peninsula, where it predominates, is of considerable extent. It forms a trough or synclinal, the southern edge of which outcrops on the Keweenaw peninsula, and to the westward along the southern shore of the lake.[4]

The discoveries of Dr. Douglas Houghton led to the exploitation of the Lake Superior district, now among the most valuable and productive copper fields in the world. The first copper in any considerable quantity was taken from what was later known as the Cliff mine, in Keweenaw county, in 1846. About 1847 the Minnesota mine, in Ontonagon county, was opened. The mine was closed in 1870, after having paid dividends of

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[1] Iron in All Ages, by James M. Swank, page 321.

[2] The Copper Handbook, by Horace J. Stevens, Vol. III, page 106.

[3] Metallic Wealth of the United States, by J. D. Whitney, page 250.

[4] The Copper Handbook, Vol. III, page 106.

$1,820,000 from 17,352 tons 668 pounds of copper produced. The mine has recently been reopened. The famous Calumet and Hecla mine, producing about 8 per cent of the copper output of the world, was opened in 1866. Up to 1903 this mine had contributed about 55 per cent of the total copper production of Michigan.[1]

The now practically abandoned mines on Isle Royal were probably worked long before the arrival of the white man, but the earliest historic explorations were contemporary with those in Keweenaw and Ontonagon counties. Several mines were located and worked to some extent until 1883. At the present time new explorations are being made in this region.[2]

The output of copper from ore mined in Houghton, Keweenaw, and Ontonagon counties was 76,385 long tons in 1902, or 26.8 per cent of the total production for the United States. From 1847 to 1887 Michigan ranked first among the copper producing states, but since that time, with the single exception of 1891, Montana has ranked first and Michigan second. In 1901 Michigan contributed 13.4 per cent of the world's production of copper.

The following table compiled from the reports of the United States Geological Survey, shows the annual production of copper in the United States and in Michigan from 1845 to 1902, and the percentage of Michigan's output to that of the United States:

TABLE 5.—*Annual production of copper in the United States and in Michigan, with per cent of total: 1845 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	PRODUCTION (LONG TONS).			YEAR.	PRODUCTION (LONG TONS).		
	United States.	Michigan	Per cent of total		United States.	Michigan	Per cent of total.
1845	100	12	12.0	1874	17,500	15,327	87.6
1846	150	26	17.3	1875	18,000	16,089	89.4
1847	300	213	71.0	1876	19,000	17,085	89.9
1848	500	461	92.2	1877	21,000	17,422	83.0
1849	700	672	96.0	1878	21,500	17,719	82.4
1850	650	572	88.0	1879	23,000	19,129	83.2
1851	900	779	86.6	1880	27,000	22,204	82.2
1852	1,100	792	72.0	1881	32,000	24,363	76.1
1853	2,000	1,297	64.9	1882	40,467	25,439	62.9
1854	2,250	1,819	80.8	1883	51,574	26,653	51.6
1855	3,000	2,593	86.4	1884	64,708	30,961	47.8
1856	4,000	3,666	91.7	1885	74,052	32,209	43.5
1857	4,800	4,255	88.6	1886	70,430	36,124	51.3
1858	5,500	4,088	74.3	1887	81,017	33,941	41.9
1859	6,300	3,985	63.3	1888	101,054	38,604	38.2
1860	7,200	5,388	74.8	1889	101,239	39,364	38.7
1861	7,500	6,713	89.5	1890	115,966	45,273	38.9
1862	9,000	6,065	67.4	1891	126,839	50,992	40.2
1863	8,500	5,797	68.2	1892	154,018	54,999	35.7
1864	8,000	5,576	69.7	1893	147,033	50,270	34.2
1865	8,500	6,410	75.4	1894	158,120	51,031	32.3
1866	8,900	6,138	69.0	1895	169,917	57,737	34.0
1867	10,000	7,824	78.2	1896	205,384	64,073	31.2
1868	11,600	9,346	80.6	1897	220,571	64,858	29.4
1869	12,500	11,886	95.1	1898	235,050	69,291	28.2
1870	12,600	10,992	87.2	1899	253,870	65,803	25.9
1871	13,000	11,942	91.9	1900	270,588	64,938	24.0
1872	12,500	10,961	87.7	1901	268,782	69,772	25.9
1873	15,500	13,433	86.7	1902[1]	285,281	76,385	26.8

[1] Census figures.

Cement.—The history of the Portland cement industry in this state begins with the year 1872, when a plant was built near Kalamazoo and operated until abandoned in 1882. No further steps in the development of this industry were taken until 1896 and 1897, when a plant was erected at Union City. This was the beginning of the recent period of rapid and extensive development of the cement industry in Michigan.

The raw materials entering into the composition of the Portland cement thus far made in Michigan are limestone, marl, shale, clay, and gypsum, all of which abound in the state.[3]

Table 6, compiled from the reports of the United States Geological Survey, shows the increase in product of the Portland cement industry in the state from 1896 to 1902.

TABLE 6.—*Annual production of Portland cement: 1896 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1896	1,000	1900	604,750
1897	15,000	1901	1,025,718
1898	77,000	1902[1]	1,577,006
1899	542,566		

[1] Census figures.

Coal.—The industry of coal mining in Michigan began in 1835 in Jackson county. This was followed in 1838 by operations on the Grand Ledge, in Ingham and Clinton counties. In 1878 coal was mined in the Owosso district in Shiawassee county, and this field has been worked continuously since that year. Successful operations first began in the Saginaw district and in Bay county in 1895. The large proportion of the product of the smaller mines finds a ready local market, while much of the output from the larger ones goes into Wisconsin, Minnesota, and the Dakotas.[4]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in the state from 1868 to 1902:

TABLE 7.—*Annual production of coal, bituminous: 1868 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1868	28,150	1886	60,434
1869	29,980	1887	71,461
1870	31,528	1888	81,407
1871	32,000	1889	67,431
1872	33,600	1890	74,977
1873	56,000	1891	80,307
1874	58,000	1892	77,990
1875	62,500	1893	45,979
1876	66,000	1894	70,022
1877	69,197	1895	112,322
1878	85,322	1896	92,882
1879	82,015	1897	223,592
1880	129,053	1898	315,722
1881	130,130	1899	624,708
1882	135,339	1900	849,475
1883	71,296	1901	1,241,241
1884	36,712	1902	964,718
1885	45,178		

Limestones and dolomites. The value of the product of the 30 quarries operating in 1902, which are located in the counties of Alpena, Charlevoix, Chippewa, Delta, Emmet, Huron, Kent, Monroe, Schoolcraft, and Wayne, was $657,072 while in 1901 it amounted to $565,931.

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[1] The Copper Handbook, Vol. III, pages 108, 109, 227, and 383.

[2] Geological Survey of Michigan, Vol. VI, page 22.

[3] United States Geological Survey, 1900-1901, Part III, page 635.

[4] Ibid., page 324 ff.

Gypsum.—Table 8, compiled from the reports of the United States Geological Survey, shows the annual production of gypsum in the state from 1868 to 1902.

TABLE 8.—*Annual production of gypsum: 1868 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1868	34,082	1886	52,369
1869	36,174	1887	54,310
1870	38,364	1888	51,682
1871	48,428	1889	131,767
1872	52,501	1890	74,877
1873	57,340	1891	79,700
1874	51,493	1892	139,557
1875	36,187	1893	124,590
1876	48,789	1894	79,958
1877	48,250	1895	66,519
1878	47,232	1896	67,634
1879	51,278	1897	94,874
1880	65,470	1898	93,181
1881	50,105	1899	144,776
1882	58,096	1900	129,654
1883	63,887	1901	185,150
1884	51,389	1902[1]	208,563
1885	49,119		

[1] Census figures.

In 1827 an Indian trapper brought a specimen of gypsum which he had picked up on Plaster creek, to the mission located on the present site of Grand Rapids. Little attention, however, was paid to the mining of gypsum until 1838, when Dr. Douglas Houghton, the state geologist, called attention to the deposits. In 1841 the first gypsum mill was built on Plaster creek, in Kent county, and in 1862 the Alabaster quarry and mill in Iosco county were opened.[1] In its ground, uncalcined state gypsum is used as land plaster for fertilizing purposes, but the greater part of the gypsum produced is calcined into plaster of Paris. The total value of gypsum produced in 1901 was $267,243, of which $208,549 was the value of plaster of Paris and $10,708 that of land plaster. In 1902 the total value was $459,621; the value of product calcined into wall plaster and plaster of Paris was $372,821 and that ground into land plaster, $16,840.

All other minerals.—Extensive beds of Potsdam sandstone occur in the northern part of the Upper Peninsula and furnish the best quality of building material found in the state. The stone is of medium fineness of texture and of a light brownish red color, often curiously spotted or mottled with gray, and is known locally as "raindrop stone."[2] The total value of the stone produced by the 9 quarries which operated in 1902 was $188,073, while in 1901 it was $290,578. The principal quarries are located in Baraga, Houghton, Keweenaw, Ottawa, and Marquette counties.

The largest grindstone quarries in the state were opened in 1838 at Grindstone city, Huron county. The Huron grindstone is a very fine grit, soft and wet when fresh, but growing hard and dry upon exposure.[3] In the production of grindstones Michigan is second among the states, Ohio standing first.

The graphite mines are located in Baraga county, the 13 petroleum wells in St. Clair county, and a small quantity of clay is produced in Ontonagon county.

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[1] Report of the State Board of Geological Survey of Michigan, 1902, page 4 ff.

[2] Stones for Building and Decoration, by George P. Merrill, page 144.

[3] King's Handbook of the United States, page 407.

MINNESOTA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Minnesota for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Iron ore.	Limestones and dolomites.[1]	Sandstones and quartzites.	Siliceous crystalline rocks.	Precious stones.
Number of mines or quarries	176	59	77	13	27	....
Number of operators	255	31	76	12	26	110
Salaried officials, clerks, etc.:						
Number	675	529	92	18	36	....
Salaries	$577,336	$430,994	$86,969	$18,654	$40,719	....
Wage-earners:						
Average number	9,760	8,256	785	305	414	....
Wages	$6,391,184	$5,376,933	$481,561	$215,068	$317,622	....
Contract work	$339,244	$338,244	$1,000	....	....	....
Miscellaneous expenses	$4,242,851	$4,134,553	$50,380	$45,740	$12,028	$150
Cost of supplies and materials	$2,868,340	$2,699,115	$103,794	$13,158	$52,273	....
Value of product	$25,729,545	$23,989,227	$905,857	$347,472	$478,989	$8,000

[1] Includes cement, 2.

By far the most important mineral found in the state is iron ore, Minnesota ranking first in the production of this mineral. The building stones of the state are of excellent quality and of great variety. Natural-rock cement has been manufactured near Mankato for many years, and the famous red pipestone is found in Pipestone county.

In addition to the minerals enumerated in Table 1 the following, which are known to occur in Minnesota, were not produced in commercial quantities during 1902: Feldspar, jasper, molybdenum, reported as occurring in quantities near Portage, Aitkin county, and slate.

In 1902 there were 15 operators, exclusive of those referred to in Table 1, who reported active mines but no production, the work being confined to the care and development of the properties. These operators employed an average of 117 wage-earners and paid $73,700 in wages during the year. The miscellaneous expenses amounted to $2,346 and the cost of supplies and materials to $66,310.

The value of the products of the manufacturing industries of the state, based primarily upon the products of mines and quarries, is shown in the following table, which also shows the total value of products for all manufactures in Minnesota:

TABLE 2.—*Manufactures based primarily upon products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$262,655,881
Based upon products of mines or quarries:		
Chemicals and allied products	$365,101	
Clay, glass, and stone products	3,521,708	
Iron and steel and their products	8,483,578	
Metals and metal products, other than iron and steel	3,210,436	
Miscellaneous industries	12,862,474	
		28,443,297
All other		234,212,584

From the figures in Table 2 it will be seen that the total value of the products of manufactures in 1900, based primarily upon minerals mined or quarried, amounted to $28,443,297, or 10.8 per cent of the total of all manufactures. The total value of the output of the mines and quarries of Minnesota in 1902 was $25,729,545, or 8.9 per cent of the total value of the products of all mining and manufacturing industries in the state.

According to the census of 1900 the average number of wage-earners engaged in the manufacturing industries was 77,234, and the total wages paid amounted to $35,484,825. The average number engaged in mining and quarrying in Minnesota in 1902 was 9,760, and the total wages paid amounted to $6,391,184. The manufacturing and mining industries combined, therefore, gave employment to 86,994 wage-earners and paid $41,876,009 in wages. Of these totals, manufactures employed 88.8 per cent of the wage-earners and paid 84.7 per cent of the wages. Mines and quarries gave employment to 11.2 per cent of the wage-earners and paid 15.3 per cent of the wages.

The following table presents the value of the output of the leading minerals of this state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Iron ore.	Limestones and dolomites.	Siliceous crystalline rocks.	Sandstones and quartzites.
1890	(1)	$613,247	$356,782	$131,979
1891	(1)	600,000	(1)	290,000
1892	$3,090,942	600,000	360,000	176,000
1893	2,321,204	208,088	270,226	80,296
1894	2,165,802	291,263	133,996	8,416
1895	2,803,432	218,753	148,596	74,700
1896	5,296,664	228,992	155,297	202,900
1897	4,029,077	236,397	92,112	158,057
1898	4,659,649	245,685	79,309	175,810
1899	9,924,853	496,482	159,459	294,616
1900	24,384,893	441,554	221,684	267,000
1901	15,335,513	522,778	280,105	246,685
1902[2]	23,989,227	905,857	478,989	347,472

[1] Not reported.

[2] Census figures.

Iron ore.—The Minnesota iron mines thus far developed are in the Mesabi and Vermilion ranges in St. Louis county, and lie about 100 miles north of Duluth. They are about 20 miles apart and extend in an easterly and westerly direction, with the ore deposits scattered along the ranges in groups at irregular intervals; and thus, besides being very narrow, as compared with their length, the ore belts are composed of nonproductive reaches for miles, with occasional groups of rich mines. The ore, confined to red hematite variety, is soft, sometimes yielding 67 per cent of iron, and so low in phosphorus as to come within the Bessemer limit.

The occurrence of iron ore of the azotic system in northern Minnesota was first mentioned in 1850, but no particular importance was ascribed to this ore.[1] H. H. Eames, state geologist of Minnesota in 1865 and 1866, was the first to observe and report iron ore on both the Vermilion and Mesabi ranges and to consider it of any value.[1]

The first iron ore was shipped from the Vermilion range in 1884 and from the Mesabi range in 1892. The total production for 1884 amounted to 62,122 tons. In 1889, with a production of 864,508 tons, the state ranked fifth among the iron ore producing states, while in 1902, with a production of 15,137,650 tons, it ranked first; Michigan second, with 11,135,215 tons; and Alabama third, with 3,574,474 tons. With the exception of Great Britain and the German Empire no country in the world has reached so great a production in any year as Minnesota. Much the greater part of the ore produced goes to furnaces in Pennsylvania, New York, and Ohio, comparatively little being consumed in the state.

The state has adopted the system of leasing its iron lands, and a royalty of 25 cents per ton is imposed on all iron ore mined and shipped from state lands. To the end of the fiscal year ending July 31, 1902, the state had received in royalties on iron ore actually shipped a total sum of $332,119.02.[2]

The following table shows the yearly production of iron ore in Minnesota from 1884 to 1902, inclusive, the figures being taken from the reports of the United States Geological Survey:

TABLE 4.—*Annual production of iron ore: 1884 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1884	62,122	1894	2,968,463
1885	227,075	1895	3,866,453
1886	307,948	1896	4,283,880
1887	394,910	1897	5,601,429
1888	511,953	1898	5,963,509
1889	864,508	1899	8,161,289
1890	891,910	1900	9,834,399
1891	945,105	1901	11,109,537
1892	1,255,465	1902	15,137,650
1893	1,499,927		

Limestones and dolomites.—The state has extensive deposits of Lower Silurian limestones and dolomites. At present the only ones quarried are located in the counties of Blue Earth, Brown, Dakota, Dodge, Goodhue, Hennepin, Houston, Lesueur, Nicollet, Olmsted, Ramsey, Rice, Washington, and Winona. During 1902, 77 quarries were operated, the value of their product being $905,857, while in 1901 the value of the product from the operating quarries was $522,778. Kasota stone, or pink limestone, which is found in the quarries at Kasota and Mendota, Lesueur county, is much admired and highly valued. Other limestones quarried are usually buff, light blue, or drab in color.

The two cement producing operators, data concerning whose plants are included with limestones and dolomites, manufactured nothing but natural rock cement.

Sandstones and quartzites. The 13 quarries operating in 1902, in the counties of Carlton, Lac qui Parle, and Pine, produced a product valued at $347,472, while the product of the quarries operated in 1901 amounted to $246,685. The red sandstones of Fond du Lac are the most valuable in the state and closely resemble the Connecticut brownstone, though harder and firmer. These quarries were not operated during the year covered by this report.

Granites.—More than half the state is underlaid by the crystalline class of rocks to which granite belongs. There are large exposures of granite in the northern part of the state which are practically of little value because of their inaccessibility. Those in the southern and western part are of more importance. The first quarry was operated in 1868 in Sherburne county. Minnesota granites are both red and gray in color and vary as to fineness of their grain.[3]

The value of the product from the 27 granite quarries operating in 1902 was $478,989. These quarries were located in Benton, Bigstone, Lac qui Parle, Redwood, Renville, St. Louis, Sherburne, and Stearns counties.

Precious stones.—The value of the catlinite, or red pipestone, quarried in Pipestone county in 1902 was $2,000. This is found nowhere else in the world; is blood red, easily carved, and susceptible of a dull polish. It is famous on account of its earlier use by the Indians for pipes and ornaments.[4]

The value of the output of chlorastrolite, a nonhomogeneous metal found along the shores of Lake Superior, was $4,000; that of agate, found in the sand and gravel around the city of St. Paul, $1,000, and that of mesolite, $1,000.

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[1] Geological and Natural History Survey of Minnesota, Vol. IV., page 583.

[2] Report of State Auditor, 1901-2.

[3] Stones for Building and Decoration, by George P. Merrill, page 72.

[4] King's Handbook of the United States, page 427.

MISSISSIPPI.

There was no mining on a commercial scale in Mississippi in 1902. The clay deposits, which are widely distributed, have been utilized to some extent for brick.[1] Gypsum, probably the most important deposit of which is located near Cato in Rankin county, has been worked in former years, as have also the gypseous marls, for local use only, of southern Carroll, Attala, Leake, Holmes, northern Madison, Hinds, Rankin, and Scott counties. There was also some development in former years of the hydraulic limestone outcroppings at points in Tishomingo county.[2] Marls and phosphates are found extensively in many counties of the state, and they have been worked to some extent to supply local needs.[1] These phosphates and marls are of great value, and there appears no reason why they should not be developed on a commercial scale.[3]

Sandstones of gray and light buff color occur in Jefferson, Rankin, and Tishomingo counties. This stone, samples of which were exhibited at the New Orleans exposition in 1884–85, is fine grained but rather soft and friable and of doubtful durability as a building stone.[4] Common limestone suitable for local use is found in many sections of the state.[5]

Coal has been found in the vicinity of Alexander, but no production of this mineral has been reported.[6]

Carbonate of iron ores occur over a considerable area in the northern part of the state, and surface conditions indicate that their commercial exploitation is practicable.[7]

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[1] The New International Encyclopedia, Vol. XII, page 397.

[2] The United States Geological Survey, "Mineral Resources of the United States," 1882, page 698.

[3] Ibid., 1886, page 618.

[4] Stones for Building and Decoration, by George P. Merrill, page 146 ff.

[5] The Universal Cyclopedia, Vol. 8, page 169.

[6] The United States Geological Survey, "Mineral Resources of the United States," 1891, page 200.

[7] Ibid., 1887, page 48 ff.

MISSOURI.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Missouri for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Lead and zinc ore	Coal, bituminous.	Limestones and dolomites.	Siliceous crystalline rocks.	Clay.	Iron ore.	All other minerals.[1]
Number of mines, quarries, and wells	1,045	374	384	142	11	25	34	75
Number of operators	973	374	345	136	9	25	27	57
Salaried officials, clerks, etc.								
Number	1,138	777	120	155	16	20	15	35
Salaries	$1,233,811	$727,021	$325,147	$129,291	$11,614	$10,115	$14,766	$15,857
Wage-earners:								
Average number	15,351	6,612	6,501	1,434	179	120	149	357
Wages	$8,757,367	$3,691,925	$3,927,158	$752,178	$104,624	$66,169	$57,475	$157,840
Contract work	$172,514	$105,877	$42,031	$14,595	....	$77	$500	$9,434
Miscellaneous expenses	$2,118,436	$1,768,158	$250,078	$51,506	$8,256	$11,704	$8,373	$25,061
Cost of supplies and materials	$2,859,018	$2,189,161	$304,821	$262,222	$82,104	$11,123	$26,052	$33,235
Value of product	$20,284,656	$12,555,580	$5,374,642	$1,697,139	$157,708	$134,862	$106,379	$258,346

[1] Includes operators as follows: Barytes, 28 (31 mines); cement, 1; infusorial earth, tripoli, and pumice, 2; mineral pigments, crude, 2; natural gas, 9 (13 wells); nickel and cobalt, 1; petroleum, 2 (10 wells); sandstones and quartzites, 10; sulphur and pyrite, 2.

In the production of zinc Missouri ranks first, the mines in the far southwestern portion of the state yielding a large annual output, and in the central, southeastern, and southwestern parts of the state lead is found in great quantities. Bituminous and cannel coal underlie some 26,000 square miles of the area of the state, being a continuation of the Iowa Coal Measures. The iron fields in the southeastern part of the state produce the red and brown hematite varieties of ore. Quarries of brown, red, and buff sandstone; white, red, and colored marble, hydraulic and Portland cement, rock slate, gypsum and limestone also exist.[1] By virtue of its extensive clay deposits the state ranked seventh in 1902 among the states in the value of its product of clay. Over one-half the output of barytes in the United States is quarried in Missouri.

In addition to the minerals shown in the foregoing table the following minerals are found in this state, but were not produced in commercial quantities in 1902: Gold, gypsum, manganese ore, marble, mica, sandstone, slate, and silver.

In 1902 there were 27 operators who reported active mines but no production, the work being confined to the care and development of the properties. These operators employed an average of 67 wage-earners and paid $43,213 in wages during the year. The salaried officials, clerks, etc., received $10,220, the contract work amounted to $12,149, the miscellaneous expenses to $3,225, and the cost of supplies and materials to $22,352.

The value of the products of the manufacturing industries of Missouri in 1900, based primarily upon the products of mines and quarries, is shown in the following table, which also shows the total value of all manufactured products in the state, as reported at the Twelfth Census:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$385,492,784
Based upon products of mines or quarries		
Chemicals and allied products	$6,364,080	
Clay, glass, and stone products	8,533,017	
Iron and steel and their products	27,183,663	
Metals and metal products, other than iron and steel	15,876,274	
Miscellaneous industries	23,002,140	
		80,959,175
All others		304,533,609

From the foregoing table it will be seen that the value of the products of the manufacturing industries, based primarily upon the products of mines and quarries, was $80,959,175, or 21 per cent of the total manufactures reported for 1900. The value of the output of the productive mines, quarries, and wells in Missouri for 1902 was $20,284,656, or 5 per cent of the combined value of the mineral products of 1902 and the manufactured products of 1900.

The Twelfth Census reported the average number of wage-earners engaged in manufactures in Missouri as 134,975 and the wages paid as $60,719,428. The average number engaged in mining in 1902 was 15,351, and the wages paid amounted to $8,757,367. Employment was therefore given by the two industries to 150,326 wage-earners, who received $69,476,795 in wages. Of these totals, manufactures employed 89.8 per cent of the wage-earners and paid 87.4 per cent of the wages, while mining gave employment to only 10.2 per cent of the wage-earners and paid 12.6 per cent of the wages.

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[1] King's Handbook of the United States, page 149.

The following table shows the value of the annual production of the principal minerals except lead ore, separate values for which can be obtained only for 1900 and 1901, when the production amounted to $3,726,202 and $4,849,595, respectively:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Zinc ore.[1]	Coal, bituminous.	Limestones and dolomites.	Siliceous crystalline rocks.	Iron ore.	Clay.
1890	$2,256,783	$3,382,858	$1,859,960	$500,642	$91,031	(2)
1891	2,673,065	3,283,242	1,400,000	400,000	(2)	(2)
1892	2,862,175	3,369,670	1,400,000	325,000	237,827	(2)
1893	2,245,028	3,562,757	861,563	388,803	160,532	(2)
1894	1,337,900	2,634,564	578,802	798,757	106,235	(2)
1895	1,505,685	2,651,612	897,318	128,987	16,968	(2)
1896	1,831,856	2,518,194	802,968	107,710	12,800	(2)
1897	1,795,948	2,887,884	1,018,202	97,857	600	$251,001
1898	2,327,621	2,871,296	735,275	78,135	120,345	238,982
1899	5,974,624	3,591,945	977,880	151,688	42,303	575,100
1900	5,711,652	4,280,328	1,079,345	139,103	62,745	247,204
1901	5,398,671	4,707,164	1,362,272	95,806	33,742	288,339
1902	7,052,819	5,374,642	1,097,159	157,708	100,379	131,862

[1] Values taken from the Fifteenth Annual Report of State Mine Inspector.
[2] Not reported separately.
[3] Includes value of accumulated ores.

Lead and zinc ore.—The principal lead and zinc ore producing districts of Missouri are the southeastern, central, and southwestern. In the southeastern district, including the counties of Jefferson, Madison, St. Francois, and Washington, where lead alone is produced, the ores occur in the older Paleozoic limestones and have very little zinc associated with them. They are disseminated in small grains through the solid limestone, and to distinguish between them and the concentrated ores of the southwest they are called disseminated ores.[1] In the central district but little has been done toward developing lead ore mining. In the southwestern region, commonly known as the Joplin district, which extends into the adjoining corners of Arkansas, Indian Territory, and Kansas, the lead ores occur in connection with zinc, and are found in crevices and cavities in irregular deposits, but at the present time the production of zinc ore in this district is far greater than that of lead.

In 1705 an expedition prepared by the governor of Louisiana ascended as far north as the mouth of the Kansas river in search of precious metals.[2] The celebrated Mine La Motte was discovered in 1715 by M. de la Motte Cadillac.[2] In 1719 the Sieur de Lochon commenced mining on the Meramec river, but with little success.[2] In June, 1721, Sieur Renault, superintendent of the Meramec mines, discovered the mine Renault, which he continued to work until 1742.[2] Work was not again resumed here until the nineteenth century. In 1763 Francis Burton discovered the rich mines now known as the Potosi mines.[2] The first regular shaft was sunk in the Meramec or southeastern district in 1798,[3] and this district has since continued to be a large producer of lead ore.

The lead and zinc ore deposits of southwestern Missouri were discovered in 1851,[4] since which time they have been continuously worked, with the exception of an interruption during the Civil War. In 1872[4] the zinc ore, associated with the lead found in this district, began to attract attention, and has now become more important than the lead ore.

In 1902, only lead ore was produced in Douglas, Franklin, Madison, Miller, Morgan, and St. Francois counties; only zinc ore was produced in Howell, Ozark, and Wright counties; and both ores were produced in Benton, Cole, Greene, Jasper, Jefferson, Lawrence, Moniteau, Newton, and Washington counties.

St. Francois county is the largest producer of lead ore in Missouri; in 1902 its output was 83,401 short tons, valued at $3,584,307, about 67 per cent of the total lead ore production of the state for 1902. Of the 8 operators in this county, 7 had each an output valued in excess of $100,000 and 1 in excess of $1,000,000. Jasper and Newton counties are also very large producers of lead and zinc ores, 39 mines each exceeding $50,000 in value of output.

The following table shows the annual production of lead and zinc ores in Missouri to the present time:

TABLE 4.—*Annual production of lead and zinc ores: 1873 to 1902.*

YEAR.	Zinc ore (short tons).[1]	Lead ore (short tons).[2]	YEAR.	Zinc ore (short tons).[1]	Lead ore (short tons).[2]
1873	960	11,840	1888	61,550	22,010
1874	5,100	15,160	1889	82,357	31,780
1875	3,600	16,400	1890	100,218	28,840
1876	11,300	22,550	1891	125,752	31,000
1877	10,000	24,680	1892	131,488	32,200
1878	12,000	23,112	1893	108,591	(3)
1879	20,000	22,396	1894	89,150	(3)
1880	27,500	24,850	1895	101,293	(3)
1881	35,700	25,630	1896	92,754	(3)
1882	34,900	23,870	1897	93,148	(3)
1883	35,700	18,490	1898	139,058	(3)
1884	43,200	11,330	1899	181,420	
1885	42,200	20,916	1900	186,233	[4] 78,839
1886	48,400	22,780	1901	221,074	[4] 109,376
1887	57,300	16,750	1902[4]	240,057	124,537

[1] Figures from Annual Report State Mine Inspector, 1901, pages 15 and 169.
[2] Figures to 1893 from The Mineral Industry, Vol. II, 1893, page 387.
[3] Not reported separately.
[4] Census figures.

Coal.—The Coal Measures of Missouri, comprising an area of about 22,995 square miles,[5] are part of the Western Interior coal field, which also includes Iowa, Kansas, and Nebraska. Some cannel coal is mined, but the bituminous greatly predominates.

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[1] The Mineral Industry, 1894, Vol. III, page 405.
[2] Geological Survey of Missouri, 1873–74, Vol. 1, pages 11 and 12.
[3] Sixteenth Annual Report, State Mine Inspector of Missouri, 1902, page 146.

[4] The Mineral Industry, 1893, Vol. II, page 388.
[5] Geological Survey of Missouri, 1872, Part II, page 5.

It is probable that very little coal was mined in Missouri before 1840,[1] when the earliest reports of production were made. As the state suffers from the disadvantage of being surrounded by other coal producing states whose product can be mined more cheaply, it has to depend very largely upon local markets, and any increased production should therefore be considered as indicating a growth in local population and industry.

Coal production was reported in 1902 from 33 counties, with a total of 384 mines. Macon county produced the greatest quantity, 1,064,726 short tons; Lafayette was next with a production of 543,801 short tons, and Randolph third with 424,167 short tons.

The following table, from the 1902 report of the United States Geological Survey, shows the annual coal production in the state to date:

TABLE 5.—*Annual production of coal, bituminous: 1840 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

Year	Short tons.	Year.	Short tons.	Year	Short tons.
1840	9,971	1861	300,000	1882	2,240,000
1841	12,000	1862	320,000	1883	2,520,000
1842	15,000	1863	360,000	1884	2,800,000
1843	25,000	1864	375,000	1885	3,080,000
1844	35,000	1865	420,000	1886	1,800,000
1845	50,000	1866	450,000	1887	3,209,916
1846	68,000	1867	500,000	1888	3,909,967
1847	80,000	1868	541,000	1889	2,557,823
1848	85,000	1869	550,000	1890	2,735,221
1849	90,000	1870	696,562	1891	2,674,606
1850	100,000	1871	725,000	1892	2,733,949
1851	125,000	1872	784,000	1893	2,897,442
1852	140,000	1873	784,000	1894	2,245,039
1853	160,000	1874	789,680	1895	2,372,393
1854	175,000	1875	840,000	1896	2,331,542
1855	185,000	1876	1,008,000	1897	2,665,626
1856	200,000	1877	1,008,000	1898	2,688,321
1857	220,000	1878	1,008,000	1899	3,025,814
1858	240,000	1879	1,008,000	1900	3,540,103
1859	260,000	1880	1,680,000	1901	3,802,088
1860	280,000	1881	1,960,000	1902	3,890,154

Limestones and dolomites.—It is probable that underlying 25,000 square miles of this state there are good deposits of limestone,[2] but in 1902, of the 142 quarries in operation, only 47 had a value of product severally in excess of $10,000. The product of the largest quarries located in St. Louis county are light drab in color, and are extensively used in building.

Missouri is sixth in rank among the limestone producing states, the value of the production for 1902 being $1,697,139, an increase over 1901 of $334,867.[3]

Siliceous crystalline rocks.—Although there are almost inexhaustible quantities of granite in the northern part of Iron and Madison counties and the southern portion of St. Francois, only a few quarries are worked systematically.[3] The 11 quarries operated in 1902, all in St. Francois, Wayne, Iron, and Madison counties, produced gray and red granites of various shades. The value of the output in 1902 was $157,708; a gain of $61,902 over 1901.

Clay.—Missouri ranks seventh among the states in the value of the products of clay, which in 1902 amounted to $5,166,414. Of this, $1,832,118, or about 35 per cent, was the value of the common brick produced. The value of the raw clay produced in 1902 was $134,862.[4]

Iron ore.—There are three distinct iron ore fields in Missouri, known as the Iron Mountain, the Southwestern, and the Southeastern districts. Of these the Iron Mountain district is the most important. The first iron ore in Missouri was probably mined about 1816, in which year a small furnace for smelting iron was erected near Stouts creek, in Iron county. In 1845 the Iron Mountain and Pilot Knob region was developed.[5] Over 3,000,000 long tons of ore have been taken from Iron Mountain since its development.

The following table, compiled from the reports of the United States Geological Survey, shows the annual output of the Missouri iron mines since 1884:

TABLE 6.—*Annual production of iron ore: 1884 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1884	233,225	1894	81,926
1885	169,162	1895	12,512
1886	379,776	1896	4,535
1887	427,735	1897	600
1888	217,931	1898	[1] 205,347
1889	265,718	1899	22,720
1890	181,690	1900	41,366
1891	106,949	1901	14,230
1892	118,491	1902	66,308
1893	77,863		

[1] Includes accumulated ores.

All other minerals.—The barytes mined in the state is associated for the most part with limestone, and even where this has become decomposed to some depth, leaving a residual clay-like material, the barytes has not altered. The value of the 31,334 short tons produced in 1902 by the 34 mines was $104,677. The total production for the United States amounted to 61,668 short tons, valued at $203,154.

Portland cement was first produced in Missouri in 1902, but no separate figures for either the production or the value can be shown without exposing individual operations.

The so-called "tripoli," found in Newton county, was mined by two operators in 1902. This material, which is evidently residual silica, is especially adapted for filtering purposes and can readily be cut into any desired shape.[1] The quarries were first opened in 1872.[2]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 308.

[2] Stones for Building and Decoration, by George P. Merrill, pages 74 and 313.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 696 to 699.

[4] United States Geological Survey, "Mineral Resources of the United States," 1902, page 719.

[5] Geological Survey of Missouri, 1873-74, Vol. 1, pages 15 and 16.

The mineral pigments, crude, produced in the state in 1902, came from quarries located in Cape Girardeau and Ozark counties.

The 13 gas wells are in Bates, Cass, and Jackson counties. The value of the gas produced in 1902 was $2,154, while in 1889 it was $35,687.

The only nickel and cobalt produced in the United States during 1902, except a little from North Carolina and Oregon, were as by-products from Mine La Motte, a celebrated lead mine in Madison county. The 20 tons of matte containing these metals yielded 5,748 pounds of metallic nickel and 3,730 pounds of cobalt oxide.

The 10 productive petroleum wells in 1902 were in Bates and Jackson counties.

The 2 pyrite mines were located in Crawford and Phelps counties.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 881

[2] Fifteenth Annual Report Missouri State Lead and Zinc Mine Inspector, 1901, page 164.

MONTANA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Montana for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Copper.	Gold and silver.	Coal, bituminous.	Precious stones.	Limestones and dolomites.	Sandstones and quartzites.	Siliceous crystalline rocks.	All other minerals.[1]
Number of mines or quarries	281	27	176	37	3	10	8	3	17
Number of operators	271	27	176	34	3	10	8	3	10
Salaried officials, clerks, etc.:									
Number	571	310	185	61	2	4	2	1	6
Salaries	$912,477	$494,415	$318,020	$80,674	$1,700	$4,091	$3,900	$1,450	$8,227
Wage-earners:									
Average number	10,539	6,388	2,278	1,587	39	91	57	21	78
Wages	$11,812,150	$7,339,773	$2,688,052	$1,516,043	$43,664	$70,078	$52,117	$26,488	$75,935
Contract work	$64,636	$40,975	$19,161	$1,000					$3,500
Miscellaneous expenses	$893,258	$456,108	$310,145	$118,698	$825	$829	$3,882	$278	$2,493
Cost of supplies and materials	$5,067,102	$3,649,127	$1,070,300	$233,930	$5,920	$8,035	$5,810	$2,581	$32,397
Value of product	$28,295,085	$20,563,350	$4,688,505	$2,443,447	$115,000	$101,725	$85,152	$77,159	$187,822

[1] Includes operators as follows: Corundum and emery, 1; flint, 1; graphite, 1; sandstones (grindstones and pulpstones, operator reported under sandstones and quartzites); gypsum, 2; iron ore, 3; manganese ore, 1; marble, 1.

Foremost among the minerals in Montana is copper, in the production of which the state leads the world. Millions of dollars worth of gold and silver have been mined since the discovery of gold in the state in 1852. Bituminous coal in large quantities is found along the Missouri and Yellowstone rivers.[1]

Deposits of iron ore, of lead and zinc ores, of graphite and of manganese ore have been found in the state, and have been mined to a greater or less extent. The rocks of the state include granites, sandstones, marbles, and limestones in great abundance and variety. Corundum, flint, quicksilver, tin, platinum, tungsten, and stones suitable for grindstones are also found, and the Montana sapphire is well known among the precious stones.

Of the total value of the product of the mines and quarries in the state in 1902 copper ore contributed 72.8 per cent, more than four times the value of any other mineral produced.

Besides those shown in Table 1, the following minerals occur in the state, but were not commercially produced in 1902: Tin, tungsten, cinnabar, lead and zinc ores, platinum, molybdenum, clay, petroleum, and magnesia.

In addition to the active mines and quarries shown in the foregoing table, 128 operators reported development work in 129 mines and quarries, distributed as follows: Gold and silver, 126; bituminous coal, corundum and emery, and marble, 1 each. The operators employed 77 salaried officials, clerks, etc., who received $83,099, and 520 wage-earners who were paid $592,626 in wages. Contract work amounting to $65,797 gave employment to 810 employees. The total amount expended for miscellaneous expenses was $37,397, and the cost of supplies and materials was $275,796.

The value of the products of the manufacturing industries of the state in 1900, based primarily upon the products of mines and quarries, is shown in the following table, which also shows the total value of products for all manufactures in Montana:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of products.	
All manufactures		$57,075,824
Based upon products of mines or quarries.		
Clay, glass, and stone products	$498,046	
Iron and steel and their products	1,198,309	
Metals and metal products, other than iron and steel	41,865,685	
Miscellaneous industries	1,929,032	
		45,491,072
All other		11,584,752

The total product of the industries based primarily upon the products of mines and quarries constituted 79.7 per cent of all manufacturing industries of the state in 1900. The value of the product of mines and quarries in 1902 and manufactures in 1900 amounted to $85,340,909; manufactures contributing 66.9 per cent and mines and quarries 33.1 per cent of the combined value. Manufactures in 1900 and mines and quarries in 1902 gave employment to 20,656 wage-earners and paid $19,782,036 in wages, mines and quarries employing 51 per cent of the wage-earners and paying 59.7 per cent of the wages, manufactures giving employment to 49 per cent of the wage-earners and paying 40.3 per cent of the wages.

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[1] King's Handbook of the United States, page 516.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the annual production of gold, silver, coal, limestones and dolomites, and sandstones and quartzites in Montana since 1890. Values for copper ore can not be obtained.

TABLE 3.—*Value of annual production of certain minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Silver.[1]	Coal, bituminous.	Limestones and dolomites.	Sandstones and quartzites.
1890	$3,339,000	$20,363,636	$1,252,492	$24,964	$31,648
1891	2,890,000	21,139,394	1,228,630	(2)	35,000
1892	2,891,386	24,615,822	1,330,847	6,000	35,000
1893	3,576,000	21,858,780	1,772,116	4,100	42,300
1894	3,868,429	17,684,229	1,887,390	92,070	16,500
1895	4,101,400	22,715,600	2,850,906	95,121	31,069
1896	4,324,700	21,640,404	2,279,672	83,927	3,250
1897	4,373,400	20,257,487	2,897,408	37,300	25,644
1898	5,126,900	19,144,663	2,324,207	63,196	3,683
1899	4,760,100	20,810,990	2,347,757	113,718	26,100
1900	4,698,000	[3]8,801,148	2,713,707	141,093	59,630
1901	4,744,100	[3]7,879,020	2,009,316	143,860	58,459
1902 [4]	4,373,600	[3]7,019,214	2,443,447	104,725	85,172

[1] Estimates by the Director of the Mint, value of the refined product; silver at coining value. The values given in Table 1 are the values at the mine.
[2] Not reported separately.
[3] Commercial value.
[4] Census figures.

Copper ore.—The city of Butte dates from the discovery in 1864 of placer mines in the Missoula gulch. The placers were in no way remarkable, being duplicated elsewhere in neighboring camps. Following the exhaustion of the auriferous gravels, came the discovery and working of silver bearing ledges in the hills, but these did not add materially to the fame of the district. The Anaconda mine and others of the great properties were bought, developed, and worked with a view to their silver values.[1]

The opening of the Anaconda as a copper mine dates from 1882. At that time the dark red and brown quartz, developed for its gold and silver values, carried only traces of copper, and it was while preparing to mill this ore that the main shaft then being sunk entered the rich copper ledge at a depth of about 300 feet. This led to other discoveries.[1]

In 1870 the Lake Superior region produced 87.2 per cent of the copper product of the country. In 1875 the Lake product constituted 89.4 per cent, and in 1880 it was over 82.2 per cent. In 1882 Montana commenced to produce and advanced steadily and rapidly until in 1887 its copper output exceeded that of the Lake Superior mines. Since that date, with the single exception of 1891, it has held first place not only among the states and territories, but as the largest copper producing district in the world.

The following table shows the annual production of copper in Montana from 1883 to 1902:

TABLE 4.—*Annual production of copper: 1883 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1883	11,011	1893	69,290
1884	19,256	1894	81,729
1885	30,267	1895	84,900
1886	25,362	1896	99,071
1887	35,133	1897	102,807
1888	43,704	1898	92,041
1889	43,849	1899	100,503
1890	50,437	1900	120,865
1891	50,028	1901	102,621
1892	72,940	1902	128,975

The output for 1902 was 26,354 long tons in excess of that for 1901, an increase of over 25 per cent; but the 1901 output shows a decrease of 18,244 long tons from the product of 1900, and the 1902 product only exceeds that of 1900, the greatest up to that time, by 8,110 long tons.

Gold and silver.—Although the presence of gold in this section was probably known to the missionaries, they had other motives than the gathering of precious treasures. The discovery of gold is, therefore, apparently due to Francois Finlay, a French half-breed, who had worked in the placers of California, and when returning to the vicinity of his former home, discovered fine float gold on Gold creek, in Deerlodge county, on the western slope of the Rocky mountains. He did little more than prospect the locality.[2]

Subsequently, in May, 1858, James and Granville Stuart, Thomas Adams, and Reese Anderson prospected in Gold creek, finding dirt or gravel that showed as high as 10 cents to the pan. They were forced to abandon the work, however, because of trouble with the Indians and lack of tools and provisions. In the summer of 1860 three small sluice boxes, roughly hewed out of green timber, were operated on Gold creek by Henry Thomas. This was the first actual mining in Montana. Stuart and his party had removed to the vicinity of Fort Bridger, where they lived as traders until 1860, when they returned to investigate the affluents to the valley of the Deerlodge. They prospected during 1861 and found several favorable localities, but it was not until 1862, after receiving from Wallawalla, Wash., 425 miles distant, tools and lumber, that the first string of 10 sluices was set up and worked. They had communicated the news of their discovery to a relative at Pikes Peak, as Colorado was then called, and about the 20th of June, 1862, miners began to arrive at Deerlodge in considerable numbers. The newcomers discovered the placers at Pikes Peak gulch, Pioneer gulch, etc., and from this time the immigration of gold seekers rapidly increased.[3]

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[1] Bancroft's History of the Pacific States, page 589 ff.

[2] Mineral Resources of the United States East of the Rocky Mountains, by James W. Taylor, 1868, pages 39 and 40.

[3] Ibid., pages 39 to 51.

Alder gulch, in Madison county, was discovered in the spring of 1863 by William Fairweather, one of a party of prospectors from Bannock city. The first pan of earth yielded $1.75. Being without provisions, the party hurried back to Bannock city, and returning with friends the gulch was staked off on the 6th and 7th of June, 1863. Within less than two years Alder gulch contained five thriving towns, besides Virginia City, an incorporated city of nearly 10,000 inhabitants. This was the richest and largest "find" ever worked in Montana, and probably in the world, being nearly 20 miles in length and uniformly productive throughout the greater portion. At the head of the gulch the gold was coarse, and many nuggets were picked up varying in value from $200 to $800.[1]

The discovery of Last Chance gulch, near the site of the present city of Helena, in the summer of 1864 was the next of importance. In that summer a party of five or six men are said to have taken from one of the bars in Confederate gulch about 1,400 pounds of gold dust of a value of nearly $300,000.

In addition to the foregoing there were numerous rich diggings found both east and west of the main range. The location and working of vein mines dates from 1864. The Oro Cache lead in the summit district of Alder gulch was discovered early in that year, and work was begun on December 1 of the same year. The Whitlatch Union lead, sometimes called the Owyhee, was discovered in the winter of 1864, and work was begun the succeeding spring.[1]

The following table, compiled from various sources, shows the value of the annual gold and silver production in Montana from 1862 to 1889. The production for the subsequent years has already been given in Table 3.

TABLE 5.—*Value of annual production of gold and silver: 1862 to 1889.*

YEAR.	Gold and silver [1]	YEAR.	Gold.	Silver.
1862	$600,000	1877	$1,300,000	$750,000
1863	8,000,000	1878	2,260,511	1,669,635
1864	16,000,000	1879	2,600,000	2,225,000
1865	18,000,000	1880	1,805,767	2,905,068
1866	17,500,000	1881	2,330,000	2,630,000
1867	12,000,000	1882	2,550,000	4,370,000
1868	15,000,000	1883	1,800,000	6,000,000
1869	9,000,000	1884	2,170,000	7,000,000
1870	9,100,000	1885	3,300,000	10,060,000
1871	8,050,000	1886	4,425,000	12,400,000
1872	6,068,339	1887	5,230,000	15,500,000
1873	5,178,047	1888	4,200,000	17,000,000
1874	3,844,722	1889	3,500,000	19,393,939
1875	3,573,600			
1876	(2)			

[1] From 1862 to 1867, inclusive, compiled from "Mineral Resources of the United States East of the Rocky Mountains," by James W. Taylor, 1868, page 52; 1868 to 1879, inclusive, from "The Mineral Industry" 1892, page 188; and 1880 to 1889, inclusive, from United States Geological Survey, "Mineral Resources of the United States," 1892, page 75.

[2] Not reported.

Coal, bituminous.—The occurrence of good steam coal accessible to the Northern Pacific system was a question of importance in the development of the mining and manufacturing interests of the Northwest. A vast amount of lignite was known and in places worked, but was so poor in quality that coal was brought from Pittsburg to mix with it. In 1881 true bituminous was known to occur in but two places in Montana, one near Bozeman canyon and the other on the summit of Mullens Pass. In that year, taking these occurrences as clews, the Bozeman outcroppings were traced several miles. Another outcrop was found for 24 miles, south of Wilkeson through the forests of the Cascade mountains, and several other less important bituminous fields were discovered. The bituminous coal field north of the forty-fifth parallel is on the west flank of the Cascade and the east flank of the Rocky mountains, the few occurrences between these ranges being insignificant.

The great plains for miles away from the mountains are underlaid with beds of lignite of inferior quality, often attaining a thickness of 7 or 8 feet. As the mountains are approached the lignite, as a rule, disappears, giving place to true bituminous, and frequently a good coking coal, though the seams are of less thickness than the lignite.[2]

The production of coal in the Bozeman field began in January, 1883, and operators in the Gardiner field, along the Yellowstone, in Gallatin county, reported their first production the same year.[3]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in Montana from 1883 to 1902:

TABLE 6.—*Annual production of coal, bituminous: 1883 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1883	19,795	1893	892,309
1884	80,376	1894	927,395
1885	86,440	1895	1,504,193
1886	49,843	1896	1,543,445
1887	10,202	1897	1,647,882
1888	41,467	1898	1,479,803
1889	363,301	1899	1,496,451
1890	517,477	1900	1,661,775
1891	541,861	1901	1,396,081
1892	564,648	1902	1,560,823

The total value of the coal product of the state in 1902 was $2,443,447, the largest value being shown for Cascade county, followed by Carbon, Park, Gallatin, Choteau, and Fergus, in the order named. Production is also reported for Deerlodge and Meagher counties, their combined product being valued at $2,012.

Precious stones.—The only systematic mining that has been undertaken for sapphires is in Montana. Sapphires were first found in this state by miners who were washing the gravels of the bars on the Missouri river for gold. These were first described in 1873, but actual mining did not begin until 1891. These bars are located from 12 to 18 miles northeast of Helena and have been followed from Canyon Ferry to American bar, a distance of about 12 miles. Sapphires are also found in the gravel of Maple gulch, about 1 mile above Emerald bar, the intermediate gravels being barren. These stones are for the most part of a pale green or greenish yellow color, with an occasional pink and yellow, while those approaching a red or blue color are extremely rare. Sapphire has also been found at Rock creek, Cottonwood creek, and Yogo gulch. From these deposits stones of deeper color have been obtained, those from Rock and Cottonwood creeks ranging from red to blue, and those from Yogo gulch being all blue.[1] Smoky quartz has also been found at Three Mile gulch, near Helena. A gigantic crystal weighing 93½ pounds was found on Clear creek, in Jefferson county. Montana is the chief western source of supply for the amethyst. In 1895 a crystal weighing 12 pounds was found on Granite creek, and in 1900 remarkable discoveries were made in Jefferson county about 22 miles southeast of Butte. The amethyst in this locality occurs in fine crystals curiously mingled with quartz. The amethyst itself is free from foreign substances, though occasionally parts of the same crystals are composed of tourmaline.

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[1] Mineral Resources of the United States East of the Rocky Mountains, 1868, pages 39 to 51.

[2] Tenth Census, Vol. XV, pages 691 and 692.

[3] United States Geological Survey, "Mineral Resources of the United States," 1883, page 53.

Besides those already named, beryl, aquamarine, garnet, chrysoberyl, white topaz, opal, agate, and moss agate are frequently found in the gold bearing gulch soils.[2]

Limestones and dolomites.—Though the occurrence of limestone is known in almost every one of the 26 counties and the Crow reservation, only 8 reported the quarrying of limestone in 1902. The largest product was shown for Cascade county and the second largest for Jefferson county, their entire production being used as blast furnace flux. Lewis and Clarke county was third, where about one-fourth of the production was used for building, more than one-half for blast furnace flux, and the remainder for flagging. Powell county was fourth, the entire production being burned into lime. The fifth county in value of product is Flathead, followed by Park, Sweet Grass, and Yellowstone in the order named. Of the total production in the state, $88,000 was used for flux; $8,775 for lime burned; $6,375 for building purposes; and the remainder for flagging and rubble.

Sandstones and quartzites.—A fine light gray sandstone, somewhat resembling the Berea, Ohio, stone, occurs in considerable abundance in Rocky canyon, Gallatin county, the formation permitting the removal of large blocks which work readily when first removed, but harden on exposure. A compact, red quartzite, found near Salesville, in the same county, and a fine, very light stone quarried near Dillon, in Beaverhead county, are coming into use.[3] Sandstone also forms one of the strata of the Coal Measures of Montana, often cleaving the coal seam and sometimes attaining a thickness of 50 feet.[4]

In 1902 Yellowstone county showed the largest production, $62,162. The amount used for building purposes was $54,430, of which $51,638 was the value of dressed stone. The other counties reporting were Cascade and Flathead.

Siliceous crystalline rocks.—A fine grained light gray granite occurs in Lewis and Clarke county, and a coarse hornblende-mica granite is found in the copper region near Butte. This latter rock is of good quality, but requires careful selection, as those portions in close proximity to the ore veins are charged with pyrite, which oxidizes on exposure. There is abundance of granite in the state, but for lack of a market quarrying is not extensive.[5] Two of the three quarries reporting in 1902 were located in Lewis and Clarke county, and the third in Jefferson county, the total output being valued at $77,050. Almost the entire production from Lewis and Clarke county was dressed for building purposes. Of the total production the value of stone for building purposes amounted to $32,600, and that used for riprap to $43,800.

All other minerals.—The property of the Montana Corundum Company, consisting of four claims and the mineral rights in 3,000 acres of land, was located in 1901. The ground upon which the corundum was discovered has been used as a stock range for nearly thirty years, and no doubt in the last ten years hundreds of people have passed over the "float" crystals without stopping to inquire their nature. A farmer and prospector exhibited, in the winter of 1900–1901, to a druggist from Hoopston, Ill., a crystal and a pocketknife, the blade of which gave evidence of the hardness of the crystal found. The druggist recognized the mineral, and after a careful search of the vicinity where the crystal was found definitely located the vein. A shaft 85 feet deep was sunk, from the bottom of which a drift was run along the vein—to the west 165 feet and to the east 72 feet. The vein thus far developed measures from 26 to 48 inches between the walls, with a pay streak varying from 14 to 42 inches in width. Numerous shafts, surface crosscuts, and pits have prospected the vein for a distance of over 1½ miles.[6]

In 1902 one flint quarry was reported as in operation near Basin, in Jefferson county, the entire production being sold crude as a flux in metallurgical operations.

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[1] Bureau of Agriculture, Eighth Biennial Report, 1902, "Labor and Industry of Montana," pages 312 to 320.

[2] History of the Pacific States, by Hubert H. Bancroft, Vol. XXVI, page 598.

[3] Stones for Building and Decoration, by George P. Merrill, page 148.

[4] Bureau of Agriculture, "Labor and Industry of Montana," 1901–2, page 376 ff.

[5] Stones for Building and Decoration, page 75.

[6] Bureau of Agriculture, Eighth Biennial Report, "Labor and Industry of Montana," page 443.

Prior to 1887 a deposit of graphite was discovered in Van Camps canyon, 18 miles from Dillon, but it was not systematically developed until 1901. The vein is a true fissure, and varies in width from 12 inches to a few feet. The ore has been tested and declared equal to the best grades imported from Ceylon.[1]

The sandstone quarries at Columbus, Yellowstone county, reported a portion of their product as manufactured into grindstones. It is a fine even-grained sandstone, and produces an article equal to the well-known Berea grindstone.[2]

Gypsum was discovered in 1893, in Carbon county, 8 miles from Bridger, the nearest railroad station, which is 29 miles from Billings on the main line of the Northern Pacific. Active development began in 1894, and in spite of the long haul by wagon the gypsum has been placed in successful competition with the eastern product. The deposit, from 2 to 10 feet thick, lies almost flat, about 30 feet below the surface of the ground. In 1900 another quarry was opened in Cascade county; the gypsum vein is about 16 feet thick and lies flat under several feet of limestone. The mill of this plant is located on a branch of the Montana Central Railway; the mine being directly back and up the hill, gravity is largely helpful in handling the rock.[3]

The work of the Northern Transcontinental Survey proved the existence of extensive deposits of iron ore in the mountain region of Montana. Notable among these is a mass of magnetic ore on East Boulder creek, Gallatin county, and on Cable mountain in Deerlodge county. The ore from the latter locality will average from 55 to 60 per cent metallic iron, is low in phosphorus and sulphur and practically free from titanium.[4]

In previous years the state has been comparatively unimportant as far as the production of manganese ore is concerned. In 1902, 9,000 tons of ore were mined, and stocked at the mines, from two deposits in Jefferson county. Analysis of the ore is said to show 45 per cent and over of manganese. It would also be valuable as a flux.[5]

About 5 miles southwest of the city of Helena a vast ledge of marble containing several grades of this mineral has been located.

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[1] Bureau of Agriculture, Eighth Biennial Report, "Labor and Industry of Montana," page 467.

[2] Ibid., page 465.

[3] Bureau of Agriculture, Eighth Biennial Report, "Labor and Industry of Montana," page 461.

[4] Tenth Census, Vol. XV, page 472.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 141.

NEBRASKA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Nebraska for 1902.

TABLE 1.—*Summary: 1902.*

	All minerals.[1]
Number of mines or quarries	36
Number of operators	35
Salaried officials, clerks, etc.:	
Number	12
Salaries	$8,001
Wage-earners:	
Average number	178
Wages	$95,935
Miscellaneous expenses	$2,790
Cost of supplies and materials	$11,173
Value of product	$148,391

[1] Includes operators as follows: Infusorial earth, tripoli, and pumice, 1 (2 quarries); limestones and dolomites, 33; sandstones and quartzites, 1.

Of chief importance among the natural resources of Nebraska are its rocks of various kinds and qualities. Sandstone, chalk rock, limestone, and magnesia rock abound. Fire and mineral clays are of extensive occurrence in the northern counties, and a fuller's earth of superior quality was discovered in Cherry county a few years ago.[1] Bituminous and lignite coal underlie the eastern counties and the valley of the Republican river.

These beds furnish fuel for local use, but up to the present time the deposits have not been worked commercially.[2]

Table 2 shows the value of the products of the manufacturing industries of Nebraska, based primarily upon minerals mined and quarried, as well as the value of all manufactured products of the state, as reported at the census of 1900.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product	
All manufactures		$143,990,102
Based upon products of mines or quarries:		
Chemicals and allied products	$954,849	
Clay, glass, and stone products	1,365,120	
Iron and steel and their products	1,012,236	
Metals and metal products, other than iron and steel	24,671,289	
Miscellaneous industries	4,097,761	
		32,101,255
All other		111,888,847

From the foregoing table it will be seen that the value of the products of manufactures, based primarily upon minerals mined and quarried, was $32,101,246, or 22.3 per cent of the total. The value of the output of the mines and quarries of Nebraska in 1902 was $148,391, or about one-tenth of 1 per cent of the value of all its manufactured products in 1900.

The average number of wage-earners engaged in manufactures in Nebraska in 1900, as reported at the Twelfth Census, was 24,461, and the wages paid them amounted to $11,570,688. The average number of wage-earners engaged in mining and quarrying in 1902 was 178, and the wages paid them amounted to $95,935. The combined figures give 24,639, as the number of wage-earners, and $11,666,623 as the wages paid in the combined industries. Manufactures employed 99.3 per cent of the wage-earners, and paid 99.2 per cent of the wages: while mines and quarries employed only seven-tenths of 1 per cent of the wage-earners and paid eight-tenths of 1 per cent of the wages.

Limestones and dolomites.—The carboniferous limestone of this state is suitable for building, as is also the siliceous limestone found in Sarpy county.[3]

The 33 quarries operating in 1902, all of them in Cass, Cheyenne, Furnas, Gage, Greeley, Johnson, Nemaha, Sarpy, and Thayer counties, had an output valued at $145,473. Of this amount $69,330 was reported from Cass county, $34,237 from Gage, and $22,795 from Nemaha.

The following table, compiled from the reports of the United States Geological Survey, shows the annual value of limestone quarried in Nebraska from 1890 to 1902:

TABLE 3.—*Value of annual production of limestones and dolomites: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Value.	YEAR.	Value.
1890	$207,019	1897	$42,359
1891	176,000	1898	78,193
1892	180,000	1899	125,017
1893	158,927	1900	107,906
1894	8,228	1901	154,717
1895	7,376	1902[1]	145,473
1896	10,655		

[1] Census figures.

The production of the two pumice quarries and of the single sandstone quarry can not be shown without disclosing individual operations.

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[1] Nebraska's Resources, by George W. Hervey, page 6.

[2] King's Handbook of the United States, page 526.

[3] Stones for Building and Decoration, by George P. Merrill, page 315.

NEVADA.

Table 1 is a summary of the statistics for the productive mines and quarries in Nevada for 1902.

Table 1.—*Summary: 1902.*

	Total.	Gold and silver.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	114	104	3	7
Number of operators	121	104	3	14
Salaried officials, clerks, etc.:				
Number	146	136		10
Salaries	$222,098	$210,838		$11,260
Wage-earners:				
Average number	1,132	1,075	2	55
Wages	$1,205,565	$1,162,337	$1,583	$41,645
Contract work	$7,944	$7,944		
Miscellaneous expenses	$177,355	$172,206	$351	$4,798
Cost of supplies and materials	$623,457	$599,928	$250	$23,279
Value of product	$3,518,430	$3,409,348	$6,115	$102,967

[1] Includes operators as follows: Borax, 1; copper ore, 1; gypsum, 1; limestones and dolomites, 1; precious stones, 8 (1 mine); siliceous crystalline rocks, 1; sulphur and pyrite, 1.

The discovery and development of mineral deposits, especially that of the Comstock lode, is responsible for the settlement and indeed the very existence of Nevada, and the history of mining is therefore to a great extent the history of the state.[1] Until the news of precious metal discoveries and the consequent influx of prospectors, Nevada was largely a desert wilderness, invaded only by missionaries and a few dauntless exploring parties. The early history is to a certain extent identified with that of Utah, Arizona, portions of Colorado, Wyoming, Oregon, and northern California,[2] and it was not until March 2, 1861, that the confines were fully established and Nevada took position as a recognized territory, advancing to statehood October 31, 1864.

Certain minerals occur in considerable quantities in various portions of the state, for which no commercial production was shown for 1902. Among the most important of these are barytes (heavy spar), found in Humboldt county; coal in the form of lignite, in Esmeralda county; cinnabar, the ore containing quicksilver, near Steamboat, in Washoe county; graphite or plumbago and magnetic iron ore (magnetite), in Humboldt county; iron ore (hematite), in Elko and Churchill counties; iron sulphuret (pyrite), in Lander and many other counties; cerussite (lead carbonate) and galenite, in Eureka county; pyrolusite or manganese dioxide, at Dun Glen and near Golconda, in Humboldt county; and roofing slate, in Esmeralda county.

In addition to the productive mines and quarries in Table 1, development work, confined to gold and silver, was reported by 82 operators. During 1902 these operators employed 574 wage-earners and paid $656,169 in wages. The 142 salaried officials, clerks, etc., received $181,172; the contract work amounted to $27,133; the miscellaneous expenses to $70,435; and the cost of supplies and materials to $454,077.

The manufacturing industries of a state depend somewhat upon the character of its mineral deposits, some of the most important manufactured products being based primarily upon materials obtained in mines and quarries. The following table will illustrate the extent to which this is true of Nevada:

Table 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$1,643,675
Based upon products of mines or quarries:		
Chemicals and allied products	$20,950	
Clay, glass, and stone products	52,350	
Metals and metal products, other than iron and steel	108,184	
Miscellaneous	139,876	
		321,360
All other		1,322,315

As shown in Table 2, the manufactured products based upon the product of mines and quarries form about one-fifth of the entire product of manufactures reported in 1900. During the same year there were employed in all branches of manufactures in the state 601 wage-earners, who were paid $416,732 in wages. In 1902 there were employed in the mines and quarries of the state 1,132 wage-earners, who received $1,205,565 in wages. Comparing these two branches of industry, it is disclosed that 34.7 per cent of the wage-earners of the combined industries, receiving 25.7 per cent of the wages, were employed in manufacturing, while 65.3 per cent of the wage-earners, receiving 74.3 per cent of the wages, were employed in mining.

Gold and silver.—In 1902 Nye county was first in precious metal production, the Tonapah mining district taking rank as the principal mining center of the state. Storey county is second in importance with its famous

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[1] History of Nevada, by Hubert H. Bancroft, page 92.

[2] Ibid., page 66.

Comstock lode, while Lincoln county, which stood first in gold and silver production in 1901, has now dropped to third place. Eureka and Elko counties are respectively fourth and fifth in rank and both show an increased production, still retaining their former relative positions among the gold and silver counties of the state. In the order of their reported production may also be mentioned Lyon, White Pine, Lander, Washoe, Humboldt, Esmeralda, Ormsby, Churchill, and Douglas counties.[1]

The following table, compiled from the reports of the Director of the United States Mint, shows the annual production of gold and silver from 1890 to 1902:

TABLE 3.—*Annual production of gold and silver: 1890 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	GOLD.[1]		SILVER.[1]	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Coining value.
1890	135,450	$2,800,000	4,450,000	$5,753,535
1891	99,169	2,050,000	3,520,000	4,551,111
1892	76,021	1,571,500	2,244,000	2,901,333
1893	46,367	958,500	1,561,300	2,018,651
1894	55,042	1,137,819	1,035,151	1,338,377
1895	75,088	1,552,200	956,200	1,236,299
1896	119,404	2,468,300	1,048,700	1,355,896
1897	143,983	2,976,400	1,228,900	1,588,881
1898	144,859	2,994,500	805,000	1,040,808
1899	107,344	2,219,000	843,400	1,090,457
1900	97,050	2,006,200	1,358,700	[2]842,394
1901	143,374	2,963,800	1,812,500	[2]1,087,500
1902	140,072	2,895,300	3,746,200	[2]1,985,486

[1] Estimates of the Director of the Mint for refined product. The values given in Table 1 are the values at the mine.

[2] Commercial value.

As seen from Table 3, the production of gold during 1898 was greater than that of any other year shown, and the product during 1897, 1898, and 1901 was slightly more than that reported for 1902. Both the quantity and value of silver produced in 1902 were greater than for any other year since 1890, in which year and in earlier years a larger production is reported. The smallest production of gold was reported in 1893 and of silver in 1898.

Gold was discovered in Nevada in Gold canyon, near Dayton, by Abner Blackburn, in July, 1849.[2] In the same year an immigrant named Hardin discovered silver in the Black Rock range, in Humboldt county.[3] Other placer and quartz mines were located in various parts of what is now Nevada, but Gold Canyon was the only district worked prior to 1857. The Comstock lode of gold and silver ore was discovered June 11, 1859, and from this time on the mining interests of Nevada have been a matter of brilliant history.[4]

The gold hunters, working up the ravines from Gold canyon and Six Mile canyon, in 1859 came across what is known as the "Comstock lode," so named for Henry Comstock, one of the claim locators. This famous channel of silver and gold ore is about 3 or 4 miles long and a quarter of a mile wide, and extends nearly north and south along the eastern slope of Mt. Davidson, principally in Storey county, at a distance of about 20 miles from the California boundary. At first the ore in the Comstock lode was worked for gold alone, but later the black metallic substance occurring so persistently in connection with the gold was discovered to be a rich sulphuret of silver.[5]

From that time on until 1877 this locality was increasingly productive. During the bonanza years—1873 to 1877—the value of the ore produced each month ranged from about $2,000,000 to $3,000,000.

The following table, compiled from the reports of the Director of the Mint, shows the quantity and value of the annual production of gold and silver from the Comstock lode district from 1859 to 1902:

TABLE 4.—*Annual production of gold and silver in the Comstock lode district: 1859 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	TOTAL.		Silver.	Gold.
	Quantity (tons of ore).	Value.		
1859	....	$80,000.00	....	$80,000.00
1860	10,000	750,000.00	$200,000.00	550,000.00
1861	140,000	3,500,000.00	1,000,000.00	2,500,000.00
1862	250,000	7,000,000.00	2,350,000.00	4,650,000.00
1863	450,000	12,400,000.00	7,460,000.00	4,940,000.00
1864	680,450	16,000,000.00	9,600,000.00	6,400,000.00
1865	430,745	15,833,720.00	9,700,232.00	6,133,488.00
1866	640,292	14,907,895.00	8,944,737.00	5,963,158.00
1867	462,176	13,738,608.00	8,243,164.80	5,495,443.20
1868	300,560	8,479,769.00	5,087,861.40	3,391,907.60
1869	279,584	7,405,578.00	4,443,346.80	2,962,231.20
1870	238,967	8,704,325.40	5,222,595.24	3,481,730.16
1871	409,718	10,249,528.65	6,149,717.19	4,099,811.46
1872	384,668	12,236,399.65	7,341,839.79	4,894,559.86
1873	448,301	21,671,990.53	13,003,187.13	8,668,793.40
1874	526,742	22,476,785.15	13,486,071.09	8,990,714.06
1875	546,425	25,825,521.54	15,495,312.92	10,330,208.62
1876	598,818	31,618,660.20	18,971,196.12	12,647,464.08
1877	562,519	36,301,536.70	21,780,922.02	14,520,614.68
1878	272,909	19,661,394.11	11,796,836.47	7,864,557.64
1879	178,276	7,093,486.82	4,292,091.49	2,801,394.33
1880	172,399	5,129,015.00	3,077,409.00	2,051,606.00
1881	76,049	1,075,620.00	645,372.00	430,248.00
1882	90,181	1,743,464.00	1,046,078.40	697,385.60
1883	125,914	2,006,348.83	1,203,809.29	802,539.54
1884	188,369	2,838,752.00	1,577,438.40	1,261,313.60
1885	226,147	3,144,602.29	1,415,071.04	1,729,531.25
1886	238,780	3,736,218.46	1,681,298.31	2,054,920.15
1887	223,682	4,511,230.63	2,030,053.78	2,481,176.85
1888	271,152	7,627,267.73	4,458,058.66	3,169,209.07
1889	286,144	5,949,923.27	3,358,949.95	2,590,973.32
1890	280,075	4,980,872.59	2,988,523.56	1,992,349.03
1891	188,647	3,452,142.55	2,071,285.53	1,380,857.02
1892	133,678	2,173,247.63	1,130,088.77	1,043,158.86
1893	109,780	1,872,104.24	748,841.70	1,123,262.54
1894	97,049	1,281,467.72	512,587.09	768,880.63
1895	63,558	914,789.47	365,915.79	548,873.68
1896	39,240	567,088.93	226,835.57	340,253.36
1897	17,850	373,014.39	149,205.76	223,808.63
1898	10,766	205,039.81	82,015.92	123,023.89
1899	6,780	171,677.90	68,671.16	103,006.74
1900	25,300	700,865.26	319,441.70	381,423.56
1901	56,577	1,267,509.00	521,032.00	746,477.00
1902	96,190	1,280,976.56	495,944.96	785,030.59
Total	10,851,748	352,798,425.00	204,653,039.80	148,145,385.20
Total mill tailings	....	18,449,863.16	....	....
Grand total	....	371,248,288.16		

From 1877 to 1900 a decreasing production indicated that the rich ore body was probably becoming exhausted. The increased production shown for 1901 and 1902 is largely due to the introduction of improved electrical machinery.

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[1] Annual Report of the Director of the Mint, 1902, page 152.

[2] Harper's Encyclopedia, Vol. IX, page 434.

[3] History of Nevada, page 103.

[4] Ibid., pages 94 and 95.

[5] Report of the Director of the Mint, 1900, page 155.

The Sutro tunnel, projected by Adolph Sutro in 1869 and finished in 1879, is nearly 4 miles long, extending from the low hills bordering Carson river valley westward to the Comstock lode. The chief objects of the tunnel were to improve the drainage and ventilation and facilitate the working of the Comstock lode, and for this service all the mining companies pay a royalty. This tunnel has been principally valuable in drainage, and without it certain of the deep workings of the lode could not have been operated successfully on account of the flooding of the lower levels of the mines.

Quartz and porphyry are generally the accompanying vein matter met with in the Comstock lode, the gangue carrying the precious metals being quartz and the inclosing walls a diorite or syenite on the west and on the east a porphyrite or trachyte formation, seamed with quartz and clay. The ore obtained, both gold and silver, is free milling and is not refractory with foreign mineral complications.[1]

The rich deposit of precious metals in the Tonapah mining district in the north central portion of Nye county, near Mt. Oddie, was discovered in April, 1900, by James L. Butler, and in August of the same year he located the eight claims now forming the regular Tonapah group. A plan of leasing the ground in small sections on a 25 per cent royalty was adopted by Mr. Butler and a considerable quantity of ore was extracted on this basis.[2]

The following table, compiled from the reports of the Director of the Mint, shows the quantity of the production of ore, and the value of its precious metal contents, in the Tonapah district for 1901 and 1902:

TABLE 5.—*Annual production of gold and silver in the Tonapah district: 1901 and 1902.*

[Reports of the Director of the Mint.]

YEAR.	TOTAL.		Silver.[1]	Gold.
	Quantity (tons of ore).	Value.		
1901	2,761	$576,146	$374,110	$202,036
1902	11,258	1,793,129	1,234,271	558,858

[1] Commercial value.

Prior to January, 1902, the work done was altogether individual, but in that year a systematic development of the property was begun by a Philadelphia syndicate which had purchased the Tonapah mines. Several shafts have been started and the deep workings show an improvement both in the quantity and quality of ore.[3]

The mining industry was considerably hampered by inadequate transportation facilities during these years. Food, supplies, and even drinking water had to be carted to the camp from other localities and the ore transported 60 miles to the nearest railroad.[4] A railroad is now being built to the mines.

The Mizpah ledge has received the greatest amount of attention, although the surface indications point to rich deposits awaiting development in other of the fifteen ledges thus far discovered in this group. The chutes in which the ore is found are sometimes from 6 to 8 feet and even more in thickness, and pitch to an angle of about 35°. The gangue substance is quartz and the ore a fine grained black sulphuret, containing much chloride of silver and small amounts of iron and manganese. There is no free gold.[4]

Sandstones and quartzites.—The commercial production of sandstone in 1902, reported only in Nye county, amounted to $6,115, of which $2,383 was sold in the rough for building purposes and $3,657 for rubble.

All other minerals.—A considerable quantity of sulphur was produced in Humboldt county during 1902. Operations were reported by one company only and the statistics are therefore not shown separately.

The only precious stone reported as produced in the state in commercial quantities during 1902 was turquoise, found principally in Lincoln county. Only one company is regularly engaged in mining gems, but numerous miscellaneous findings are reported to the small dealers.

The state's production of gypsum in 1902 was all mined in Lyon county and is reported by one company.

Borax deposits occur in Esmeralda and Churchill counties, only the former reporting a production in 1902. The borax obtained in Esmeralda county was treated by boiling, evaporation, and crystallization before being placed on the market.

Deposits of limestone predominate in the mountains of Nevada and are marked by overflows of basaltic trap rock and trachytic lavas.[5] The production during 1902 was reported from Lyon county, near Dayton.

Granite was quarried in Washoe county during 1902, and the production was sold for building and monumental purposes and for curbing.

Copper occurs in fissure veins with gold, silver, and lead, chiefly in the form of sulphide, carbonate, or oxide. A small amount was produced in 1902, all of which was subjected to the smelting process before being marketed.

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[1] Report of the Director of the Mint, 1900, page 154.

[2] Ibid., 1901, pages 172 and 173.

[3] Ibid., 1901, page 174.

[4] Ibid., 1901, page 175.

[5] History of Nevada, page 7.

NEW HAMPSHIRE.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of New Hampshire for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Siliceous crystalline rocks.	All other minerals.[1]
Number of mines or quarries	56	51	5
Number of operators	62	49	13
Salaried officials, clerks, etc.:			
Number	92	87	5
Salaries	$68,971	$65,648	$3,323
Wage-earners:			
Average number	1,253	1,219	34
Wages	$806,494	$791,196	$15,298
Miscellaneous expenses	$26,993	$26,719	$274
Cost of supplies and materials	$134,128	$132,122	$2,006
Value of product	$1,176,312	$1,147,097	$29,215

[1] Includes operators as follows: Infusorial earth, tripoli, and pumice, 1; mica, 2; oilstones, whetstones, and scythestones (2 mines, operator reported in Arkansas); precious stones, 10 (no mines).

The value of the mineral production for the state in 1902, $1,176,312, is only two-tenths of 1 per cent of the total value of all minerals mined or quarried in the United States during the year. Of the 50 states and territories from which mining operations were reported, New Hampshire ranked 41. The state produced in commercial quantities only five classes of minerals. These were, in the order of their importance, siliceous crystalline rocks, including granite, trap rock, and similar stones; mica; infusorial earth, tripoli, and pumice; oilstones, whetstones, and scythestones; and precious stones.

The value of the output of siliceous crystalline rocks for the state during 1902 was $1,147,097. This production consisted of building stone, rough and dressed, valued at $619,916; of stone for monumental purposes, valued at $346,735; of stone converted into paving blocks, valued at $101,548; and of stone for a variety of other purposes, valued at $78,898.[1]

In addition to the minerals named above, others occur in greater or less abundance, but were not mined in commercial quantities. The more important are clay, monazite, copper ore, and talc and soapstone.[2] Monazite has been identified with the granites in many localities, but nowhere in sufficient quantities or purity to warrant its exploitation.[3] Talc has been mined in small quantities in connection with other minerals.[4]

The following table shows the value of the products of manufactures in 1900, based upon the products of mines and quarries, compared with the value of products of all manufactures:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$118,709,308
Based upon products of mines or quarries:		
Clay, glass, and stone products	$2,080,657	
Iron and steel and their products	4,164,207	
Metals and metal products, other than iron and steel	956,330	
Miscellaneous[1]	3,422,200	
		10,623,394
All other		108,085,914

[1] Includes the products of 1 producer of chemicals and allied products in order to avoid disclosing its operations.

This table shows that the value of all manufactures for New Hampshire in 1900 was $118,709,308, and that the value of manufactured products based primarily on the products of mines and quarries was $10,623,394, or 8.9 per cent of the total. Tables 1 and 2 also show that the combined value of manufactures for 1900 and of mineral products for 1902 was $119,885,620. Of this amount, manufactures contributed 99 per cent and mines and quarries 1 per cent.

During 1902 there were employed in mines and quarries 1,253 wage-earners, who received $806,494 in wages. The census of 1900 reported 70,419 wage-earners employed in manufactures, at wages amounting to $27,620,247. On the basis of these figures, wage-earners engaged in manufactures constituted 98.3 per cent of the total number, and their wages amounted to 97.2 per cent of the total wages. It follows, therefore, that the wage-earners employed in mining industries constituted only 1.7 per cent of the total number employed and that they received 2.8 per cent of the wages.

Siliceous crystalline rocks.—Granite is found in every section of the state in quantities practically inexhaustible.[5] New Hampshire is one of the most mountainous of the New England states. The White mountains, extending through the upper half of the state, are practically solid granite. As early as 1623 stone was used for building construction;[6] and judging from the fact that the first settlement was made in the vicinity of prominent granite deposits, it is reasonable to suppose that this stone was used. The old state prison, erected at Concord in 1812, and the statehouse, built in the same city in 1816–19, were built of this granite, quarried in the immediate vicinity.[1] The admirable state of preservation of these buildings is evidence of the excellent quality of the stone. The New Hampshire granite is known to commerce as the muscovite-biotite granite, and is considered one of the most valuable in the United States. In texture it is as fine as many marbles, and is remarkable for the wonderful ease with which it can be worked. The Library of Congress at Washington is built of this stone.[1]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 678 and 679.

[2] Ibid., 1901, pages 160 and 711.

[3] Ibid., 1901, page 950.

[4] Ibid., 1900, page 777.

[5] Report of New Hampshire Bureau of Labor, Vol. VI, 1901-2, page 16.

[6] History of New Hampshire, by J. N. McClintock, page 29.

In the production of siliceous crystalline rocks, New Hampshire ranked fourth.[2] The total production of this stone in the United States for 1902 was valued at $18,257,944. New Hampshire contributed a product valued at $1,147,097, or 6.3 per cent.

The mineral industries of the state, according to Table 1, employed 1,253 wage-earners, with aggregate wages of $806,494. The wage-earners employed in the production of siliceous crystalline rocks numbered 1,219, or 97.3 per cent of the total, and their wages amounted to $791,196, or 98.2 per cent of the total.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of siliceous crystalline rocks since 1887:

TABLE 3.—*Value of annual production of siliceous crystalline rocks: 1887 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States"]

YEAR.	Value.	YEAR.	Value.
1887	$195,000	1895	$480,000
1888	104,800	1896	497,966
1889	727,531	1897	641,691
1890	727,531	1898	683,595
1891	760,000	1899	802,636
1892	725,000	1900	870,646
1893	442,121	1901	935,494
1894	724,702	1902[1]	1,147,097

[1] Census figures.

It will be observed that, while there has been a steady increase in value of products since 1895, previous to that date the industry experienced many fluctuations. The year 1902 was the first in which the value of the output exceeded $1,000,000.

All other minerals.—Infusorial earth and tripoli are produced in New Hampshire in small quantities. During 1902 the only deposit that was worked was on Troy mountain, in Cheshire county. The material, after it is mined, is calcined, bolted, and manufactured at Keene, by the producers of the raw material, into cleaning powders and polishers.

During 1902 Cheshire county was the only producer of mica in commercial quantities, and was credited with two operators. Mica mines have been uncovered and worked at Grafton, Grafton county; at Danbury, Merrimack county; and at Alstead, in Cheshire county. The Ruggles mine, which up to 1889 had been a constant producer since 1808, at one time contributing four-fifths of the domestic mica, was idle during 1902. While the value of the state's production of mica in 1902 was not large, the state nevertheless ranked fourth, as the entire value of the output of mica in the United States amounted to only $118,849.

The quarrying of various stones for manufacture into oilstones, whetstones, and scythestones has been an important industry in New Hampshire ever since Isaac Pike discovered a superior grit for scythestones in Grafton county in 1823.[3] The company formed to exploit the deposits now owns and operates quarries in New Hampshire, Vermont, Indiana, Massachusetts, Ohio, and Arkansas, and has mills for cutting, smoothing, and mounting the stones. Special stones of many kinds are put upon the market, and the industry shows a steady growth.[4]

During the census year there were discovered and sold a small number of beryl gems, classified as precious stones. These were all found in Grafton county and were not in any case the result of systematic search or mining.

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[1] Stones for Building and Decoration, by George P. Merrill, pages 76 and 77.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 675.

[3] The Mineral Industry, 1892, Vol. 1, page 463.

[4] Report of the Bureau of Labor of New Hampshire, Vol. VI, page 19 ff.

NEW JERSEY.

Table 1 is a summary of statistics for the productive mines and quarries in the state of New Jersey for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Iron ore.	Siliceous crystalline rocks.	Clay.	Sandstones and quartzites.	Limestones and dolomites.	All other minerals.[1]
Number of mines or quarries	162	15	49	34	22	27	15
Number of operators	151	9	46	34	22	25	15
Salaried officials, clerks, etc.:							
Number	420	138	92	35	28	15	112
Salaries	$357,066	$101,870	$64,508	$26,041	$17,847	$11,391	$135,409
Wage earners:							
Average number	5,645	1,960	947	702	118	187	1,731
Wages	$2,658,727	$773,286	$433,166	$293,232	$232,480	$80,654	$845,909
Contract work	$10,770	$10,770					
Miscellaneous expenses	$356,729	$80,114	$56,135	$19,403	$18,352	$7,883	$174,842
Cost of supplies and materials	$2,286,964	$429,231	$164,562	$67,176	$85,580	$25,044	$1,515,371
Value of product	$6,605,402	$1,228,084	$948,474	$612,721	$406,758	$188,650	$3,220,167

[1] Includes operators as follows: Cement, 2; lead and zinc ore, 1; marl, 10; slate, 1; talc and soapstone, 1.

The mineral wealth of New Jersey constitutes one of its greatest resources, and since the earliest days of its history has exerted a marked influence over its general industrial development. The most extensively utilized of the state's diversified mineral deposits is its clay, the exploitation of which has brought New Jersey into national prominence. Doubtless an important factor in their extensive development is their geographical occurrence. While brick clays are found in almost every section, nearly all the rich clays are in Middlesex county close to the navigable coast waters and the Raritan river.[1]

The metalliferous ores are mainly limited to those of iron, zinc, and copper. Lead and silver occur, and although the former has been worked, it is now abandoned, and the latter has not been found in sufficient quantities to warrant mining. The occurrence of the ores of arsenic and nickel is chiefly of mineralogical importance; no deposits or veins of workable extent have been discovered.[2]

The state from its earliest history has been an important producer of high-grade iron ore. The ore is of the magnetic variety and has a higher value per ton than that produced in any other state.[3] In 1902 the output comprised over 26 per cent of the total yield of magnetic iron ore in the country.[4] Zinc mining in the United States had its inception in New Jersey,[5] and for many years the bulk of the zinc ore mined was drawn from its deposits. The state's output of Portland cement in 1902 was approximately one-eighth of the total yield of the country. The sand deposits of southern New Jersey are of a quality that makes them valuable in the manufacture of glass, and they have been utilized for this purpose since pre-Revolutionary times.[6] The state also possesses valuable deposits of granite and sandstone that have been extensively exploited, especially during recent years. The greater part of the granite product is of crushed stone, in the output of which New Jersey exceeded every other state in 1902. Other minerals produced commercially in 1902 are marl, slate, and talc and soapstone.

In addition to these, the range of mineral deposits in the state comprises, among those of known occurrence, though not mined in 1902, the following: Asbestos, barytes, coal (bituminous), copper ores, galena, garnet, infusorial earth, magnesia hydrate and carbonate, marble, mica, plumbago, phosphate rock, sapphire, serpentine, and silver.[7]

The total expenditure for development work in 1902 was $275,950. Of this amount, $272,250 was applied to developing the cement industry. The remainder, $3,700, was expended in the development of gold and silver and iron ore deposits. Work of an experimental character was also prosecuted in connection with copper ores.

The following table shows the value of the products of manufacturing industries closely allied to or based upon the mining industry in 1900, using as their raw material the product of the mine and quarry:

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[1] The New International Encyclopedia, Vol. XII, pages 1045 and 1046.

[2] Geological Survey of New Jersey, 1900, page xxv.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 43 and 67.

[4] The New International Encyclopedia, Vol. XII, page 1045 ff.

[5] Production and Properties of Zinc, by Walter R. Ingalls, page 13.

[6] The New International Encyclopedia, Vol. XII, page 1046.

[7] United States Geological Survey, "Mineral Resources of the United States," 1887, page 760 ff.

TABLE 2.—*Manufactures based primarily upon the product of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$611,748,938
Based upon the products of mines or quarries:		
Chemicals and allied products	$49,607,710	
Clay, glass, and stone products	22,767,027	
Iron and steel and their products	76,832,967	
Metals and metal products, other than iron and steel	91,855,743	
Miscellaneous industries	25,489,273	
		266,552,720
All other		345,196,218

The total value of products of the manufacturing industries based on mining was, as shown by Table 2, $266,552,720, or 43.6 per cent of the total value of the product of all manufacturing industries in the state in 1900. There were employed in all branches of manufacture in 1902, 241,582 wage-earners, who were paid $110,088,605 in wages. In 1902 the mines and quarries of the state gave employment to 5,645 wage-earners, who received $2,658,727 in wages. Comparing the figures for these two branches of industry, it is disclosed that 97.7 per cent of the wage-earners, receiving 97.6 per cent of the wages, were employed in manufacturing, while 2.3 per cent of the wage-earners, receiving 2.4 per cent of the wages, were employed in mining.

The following table shows the value of the annual production of the principal minerals in the state, 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States"]

YEAR.	Iron ore.	Siliceous crystalline rocks.	Clay.	Sandstones and quartzites.	Limestones and dolomites.
1890	$1,341,548	$425,673	(1)	$597,300	$129,662
1891	525,612	400,000	(1)	400,000	100,000
1892	1,398,875	400,000	(1)	350,000	140,000
1893	900,458	373,147	(1)	267,514	149,116
1894	568,066	310,965	(1)	217,941	136,523
1895	612,671	151,345	(1)	111,823	140,000
1896	628,776	204,323	(1)	126,731	151,213
1897	491,858	561,782	$258,976	190,976	141,646
1898	654,148	753,513	390,872	277,217	146,611
1899	814,920	779,822	440,474	147,768	153,025
1900	956,711	1,170,555	467,881	198,234	170,005
1901	918,011	894,167	594,894	214,512	209,738
1902[2]	1,228,664	948,474	612,721	106,726	188,630

[1] Not reported separately.

[2] Census figures.

Iron ore.—The first recorded exploitation of the iron ores of New Jersey occurred in 1674 at Tinton Falls, near the town of Shrewsbury, in Monmouth county. The pioneer in the industry in the state was Henry Leonard, who came from the village of Rowley, in Massachusetts, to New Jersey and established the iron manufacture in that state. Bog ore was used in the first furnace. For more than a third of a century the industry of iron manufacture in the state, which grew rapidly from the start, was confined to the working of bog ore. Large quantities of iron were made from this ore at one time, and the industry of its mining and manufacture spread throughout southern and southwestern New Jersey and was for more than a century and a half an important factor in the industrial development of this part of the state. "Jersey pines" furnished the fuel for the furnaces and bloomeries, and oyster shells supplied the fluxing material.

The passing of bog ore mining was approximately coincident with the supplanting of charcoal as a fuel by anthracite coal, which took place about 1840.

The rich deposits of magnetite in northern New Jersey were discovered at an early day, and about 1710 settlements were made on Whippany river, in Morris county, for the purpose of smelting the iron ores in the neighborhood. Probably the first forge erected for the working of these magnetic ore deposits, which for almost two hundred years have been mined continuously, was located at a point about 4 miles northeast of Morristown. The celebrated Succasunna iron ore mine is near the place where the first forge was built. It was here that the pioneers in the industry obtained their ore, which was carried to the works in leather bags on pack horses; the bar iron was carried on horseback over the Orange mountains to Newark. Other forges were soon built in Morristown and some in Essex county, all of which for a long time and with the same crude methods of transportation drew their ore from the same source. The ores were free to all until the tract embracing the Dickerson mine was taken up on account of its minerals by John Reading in 1713 or 1714. The deposit has long been known as the "Dickerson mine," from one of the early governors, who was subsequently a United States Senator. On March 10, 1714, William Penn, by a warrant from the council of proprietors, acquired title to one of the richest iron ore mines in New Jersey. This tract was situated in Essex county, then Hunterdon, and was the site of what later was known as the celebrated Andover mine. The products of this mine were for many years carried on pack horses and in carts down the valley of the Musconetcong to a place on the Delaware called Durham, and thence transported by boat to Philadelphia.

For some years after the beginning of the eighteenth century New Jersey was the only colony outside of New England engaged in the manufacture of iron, and this was largely confined to its bloomeries. Not much progress was made in establishing the industry until about the middle of the eighteenth century; but from about 1740 to the Revolution many blast furnaces and other iron works were erected, and the iron industry, though hampered to some extent by restrictions imposed by England, was exceedingly active. The patriotic cause was afterwards greatly indebted for much of its iron and steel, so necessary to secure its success, to the enterprises built up between 1740 and 1770 within the borders of New Jersey. The old Oxford furnace, in

Warren county, built by Jonathan Robeson in 1742, is, according to tradition, the first one blown by a water blast. In 1880 it was still in operation, sharing with the Cornwall furnace in Pennsylvania the distinction of being the oldest furnace in the United States then in active operation.[1]

In 1790 the total production of iron ore in New Jersey was 10,000 tons. Forty years later it had increased to 20,000 tons, and in 1855 had reached a total of 100,000 tons. The output increased rapidly for almost two decades thereafter and in 1873 amounted to 665,000 tons. During the succeeding three or four years there was a marked decrease, the output in 1876 dropping to 285,000 tons. Then ensued another period of rapid increase, which continued throughout the remaining years of the decade, the maximum output in the history of the state, nearly 1,000,000 tons, being reached in 1882. During the next ten years the annual production remained steady, with only slight variations, at an average of about 500,000 tons. Between 1893 and 1897 the production reached the lowest figures since 1864, with a minimum output for the period of 257,235 tons in 1897.[2] The increase which was shown in 1898 has grown rapidly during each year since, closing with an output of 441,879[3] tons in 1902. This is a gratifying yield in view of the shortage of anthracite coal during the closing months of the year, which tended to retard the work of blast furnaces, and thus indirectly to affect the output of the mines.[2]

The iron ore producing district of New Jersey is a continuation of the ridge of Archean rock which, beginning in Putnam county, N. Y., extends southwest across Orange county, N. Y., and the Hudson river and, traversing northern New Jersey, runs out in Pennsylvania. Lenses of magnetic ore occur throughout its entire length. In New Jersey these are not as large as in the Adirondacks, but they are more regularly distributed. Four courses or mine belts are recognized in the state—the Ramapo, the Passaic, the Musconetcong, and the Pequest—in order from east to west.[4] Mining operations, which began in Morris county, have extended until at present they are widely distributed over the belt, the principal points of production being at Mt. Pleasant and Hibernia.[5]

The following table shows the annual production, in long tons, of iron ore from 1890 to 1902:

TABLE 4.—*Annual production of iron ore: 1890 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1890	495,808	1897	257,235
1891	525,612	1898	275,438
1892	465,455	1899	256,185
1893	356,150	1900	344,247
1894	277,483	1901	401,989
1895	282,433	1902	441,879
1896	264,999		

Siliceous crystalline rocks.—The rocks of this character have not been quarried extensively until within the last five or six years. The increase began in 1898, when the value of the output was nearly 50 per cent greater than that of 1897.[6] The maximum was reached in 1900, New Jersey then standing third among the states in the production of stones of this classification, with an output valued at more than $1,000,000.[7] The production has remained close to this figure since. The bulk of the state's yield of this classification consists of trappean rocks used principally as road materials.[8]

The belt within which occur all the granitic and gneissoid rocks enters New Jersey from New York near the Ramapo river, in Bergen county, and traverses the state in a southwesterly direction. The greatest width of the belt is less than 20 miles, while it is less than half that width at its southern extremity. Comparatively few quarries are worked throughout this area, though in many places the rocks are so situated that their exploitation is practicable at a relatively low cost. From the quarries at Dover, in Morris county, large quantities of stone for railroad construction have been taken. A good quality of granite of fine grain and even texture occurs in the Vernon valley along the eastern foot of Pochuck mountain.[8]

Clay.—The valuable clay beds of New Jersey have been known and exploited for more than a century; but their extensive occurrence and great importance to the state and the country have been understood and fully appreciated for only a comparatively short time.

The first recorded instance of clay mining in the state was in the banks of South Amboy. The clay was used in making stoneware at Van Wickle's pottery at Oldbridge, now Herbertsville, about 1800. In 1802 a second pottery was built at Sayreville, on the Raritan, and began the manufacture of stoneware from the same clay banks at South Amboy.

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[1] Iron in All Ages, by James M. Swank, page 146 ff.

[2] Geological Survey of New Jersey, 1902, pages 115 and 142 ff.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 45.

[4] The Ore Deposits of the United States, by James F. Kemp, page 123 ff.

[5] Geological Survey of New Jersey, 1902, page 119.

[6] United States Geological Survey, Twentieth Annual Report, Part VI, continued, page 279.

[7] Ibid., "Mineral Resources of the United States," 1900, page 625.

[8] Stones for Building and Decoration, by George P. Merrill, page 77 ff.

The famous fire clays of the state were first exploited after the War of 1812, probably about 1816. At about this date G. W. Price carried to Boston a boat load of fire clay, dug at Woodbridge, from the afterwards celebrated banks, and manufactured it into fire brick. Jacob Felt, about 1820, mined and carried to Boston another shipment consisting of 50 tons, for which he paid 25 cents per ton in the ground. From this beginning the mining and shipping of these clays to the same point continued for many years. In 1835 they were used in Philadelphia by Howell & Bros. in the manufacture of wall paper.

The industry of fire brick manufacture within the state had its inception in 1833, Mr. J. R. Watson, of Perth Amboy, building and operating the first plant. By this time the clay deposits were beginning to attract some attention. The Gazetteer of New Jersey stated in an issue of 1833 that "extensive beds of white pipe clay, composed principally of alumina, and infusible, have been observed between Woodbridge and Amboy." In 1840 Professor Rogers published in his final report on the Geology of New Jersey the results of a cursory examination made by him of the clay deposits, especially in the vicinity of Woodbridge, but these researches disclosed only a fraction of the full importance of the beds. During the following fifteen years the scope of the clay working industries was materially broadened. The progress is indicated by the following quotation from the State Geological Report of 1855: "Clay for making 50,000,000 fire bricks was taken out during the year from the pits at Woodbridge, Perth Amboy, and South Amboy: 2,000 tons were sold for facing paper hangings; 2,000 tons for making alum, and a considerable quantity for making fine pottery at Jersey City, Trenton, and Green Point. About 10,000 tons of stoneware clay were needed to supply the demand." Eighteen years later, in 1873, the industry of clay mining had grown to such an extent that 265,000 tons of fire clay were dug annually and sent into the market for making fire brick, fine pottery, sewer pipe, terra cotta ware, retorts, crucibles, facing for wall paper, alum, etc. The average price per ton received at that time was about $3.50.

At the same time 20,000 tons of stoneware clay were mined in the vicinity of South Amboy. This was shipped to all parts of the United States and supplied the material for the bulk of the stoneware used in the country. It brought an average price of $4 per ton.

The manufacture of fine earthenware was begun in the state in the latter fifties. In 1868 these products were turned out from 12 potteries in Trenton, and reached for the year an aggregate value of $1,500,000.

The abundance of the New Jersey clays, their superior quality, and convenience to market have made them almost essential to the successful prosecution of some of the great industries of the country.[1]

The clay wealth of the state comprises a great diversity of varieties, with characteristics that fit them for the manufacture of all the principal clay products. Except for the common brick clay of the state, which is widely distributed, the clay deposits are confined within comparatively narrow limits. The more valuable clays occur in three geographical groups. The most important is in Middlesex county, east of New Brunswick, and extends to Staten Island sound and Raritan bay. Its northern limit is a line parallel with the Pennsylvania Railroad from New Brunswick to Rahway and about 2 miles south of it, the Cheesequake creek forming its southern boundary. The district comprises an area of 68 square miles. It is within this district that the noted Woodbridge and Amboy clays, kaolins, and fire sands occur.

The second district is an extension of the first across the state and along the Delaware river southwest to Salem county, where it crosses the river and appears again in Delaware. The Trenton, Florence, and Pensauken creek clays occur in it.

The third district or group of clay deposits is within the area lying to the south and southeast of the Greensand-marl belt. The more important deposits occurring in this region are those at Conrad, in Gloucester county, and at Wheatland, in Ocean county. Of these three groups of clay deposits those of the Middlesex district are by far the most important, being superior in quality and yielding an aggregate product many times larger than that of the rest of the state combined.[2]

Clay mining as a distinct industry disassociated from the manufacture of clay products has reached a fuller development in New Jersey than elsewhere in the country, this state, in 1902, contributing almost 34 per cent of the total product of the United States.[3]

Sandstones and quartzites. Sandstone has been quarried in New Jersey from an early date, especially in Bergen, Passaic, and Essex counties, for building purposes, and for monuments and tombstones, and has proved thoroughly durable. For many years the sandstones of New Jersey, being of finer texture and less laminated than those of Connecticut, and consequently of superior quality, have been extensively used in New York and neighboring cities as a building material.[1] Among the many notable structures built of this stone may be mentioned Trinity church, New York city.[2]

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[1] Geological Survey of New Jersey, 1878, page 1 ff.

[2] Transactions of the American Institute of Mining Engineers, Vol. VI, page 177 ff.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 748.

The most extensively worked stone quarries in the state are those in the belt of red or brown sandstone which extends from the New York line in a general southwesterly direction across the state to the Delaware river,[1] comprising an area of 1,540 square miles.[3]

The principal quarrying points in the belt are in various towns of Passaic, Essex, Hunterdon, and Mercer counties. The stone, like that of Connecticut, is a granitic sandstone, cemented by iron oxides, silica, and carbonate of lime, and varying in color from light brownish gray to reddish brown. The fine grained, dark brown variety is most in demand.[1]

Limestones and dolomites.—The limestones of the state are widely distributed and have been used for many years in the production of lime and cement.[3] In former years quarrying on an extensive scale was prosecuted in the outcrops of Devonian limestone at Lower Harmony, in Warren county. This limestone, known in the market as marble, was of a grayish hue and in places banded, owing to alternate lines of light and dark minerals. It was worked mainly for the Pennsylvania market. A very beautiful limestone, known commercially as "Rose Crystal Marble," has been quarried to some extent on a subordinate ridge of the Jenny Jump mountain range, in the same county. There also occurs in association with the dolomites at Montville a beautiful deep green and oil yellow, often translucent, serpentine, but it has not as yet been quarried except for cabinet specimens.[4]

All other minerals.—Among the mineral products in the output of which New Jersey takes high rank, is Portland cement. This industry has had its inception and remarkable development practically within the last decade. Although there is an abundance of limestone in the state, it was thought for many years, in fact until quite recently, that very little, if any, of it was adapted to the manufacture of cement. Indeed, this was the opinion expressed by the state geologist in 1868, formed after an exhaustive study of the various limestones of the state.[3]

Prior to 1892 the production of Portland cement in the state was not recorded by the United States Geological Survey. Beginning in 1892 with a reported output of 20,000 barrels, it increased during the following year by 300 per cent to 60,000 barrels. The rapid growth of the industry continued through all the succeeding years of the decade, until in 1902 the total yield was 2,152,158 barrels, or more than 100 times the output of 1892. The following table shows the annual production of Portland cement since 1892:

TABLE 5.—*Annual production of Portland cement: 1892 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels	YEAR.	Barrels.
1892	20,000	1898	587,163
1893	60,000	1899	892,167
1894	72,223	1900	1,169,212
1895	155,000	1901	1,612,000
1896	247,100	1902	2,152,158
1897	430,335		

The raw materials used in the manufacture of Portland cement occur in many localities in Sussex and Warren counties, and to a limited extent in Hunterdon county. The areas of principal importance are in the Kittatinny valley and in some of the inter-Highland valleys.[5]

Zinc ore mining in the United States began in Sussex county, N. J., in 1838. The ore, which was of the red variety, was taken to the Government arsenal at Washington, where it was reduced, and the zinc used in the brass designs of the standard of weights and measures ordered by Congress. The process used, however, was too costly to permit commercial production of the metal.[6] In 1848 the New Jersey Zinc Company was organized and erected at Newark an extensive plant for the reduction of the metal. By 1852 the industry had made considerable headway, 860 tons of metallic zinc being produced. In 1853 the output increased to 1,440 tons, and for some years the state was the only producer of zinc in the country.[7]

The zinc deposits of the state occur in Sussex county on a range of hills which commences near Sparta and extends in a southerly direction through Stirling to Franklin.[8] The points of principal production have been Ogdensburg and Franklin.[8]

The marls of New Jersey have been dug for use as fertilizers since the early history of the state. The marl, or Greensand region, is in the southern part of the state, and is comprised within a belt from 6 to 15 miles in width, extending from the ocean below Sandy Hook across the state to the Delaware.[9]

The quarrying of roofing slate in New Jersey dates from about 1823, when it is believed the first quarry was opened by Mr. Evans, near the Delaware Watergap. The slate deposits of the state are extensive and occur mainly within a belt entering the state from Pennsylvania and extending entirely across the northern part of the state to the New York state line, and along the northwestern border of Kittatinny valley for a distance of about 35 miles.[10]

The state's production of soapstone in 1902 was obtained from Warren county.

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[1] Stones for Building and Decoration, page 149.
[2] King's Handbook of the United States, page 556.
[3] Geology of New Jersey, 1868, page 387.
[4] Stones for Building and Decoration, pages 217 and 365.
[5] Geological Survey of New Jersey, 1900, page 30.
[6] Production and Properties of Zinc, page 13.
[7] Metallic Wealth of the United States, by J. D. Whitney, page 348 ff.
[8] Ibid., page 348.
[9] Geology of New Jersey, 1868, page 261.
[10] Ibid., page 518.

NEW MEXICO.

Table 1 is a summary of the statistics of the productive mines and quarries of the territory of New Mexico for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous.	Gold and silver.	Copper.	Precious stones	Sandstones and quartzites	All other minerals.[1]
Number of mines or quarries	161	30	91	17	8	7	8
Number of operators	207	25	91	17	60	7	7
Salaried officials, clerks, etc.:							
Number	175	68	75	24	3	....	5
Salaries	$209,569	$85,750	$80,290	$32,129	$5,100	....	$6,300
Wage-earners:							
Average number	2,275	1,439	519	164	36	8	109
Wages	$1,646,834	$1,027,280	$409,779	$128,483	$22,187	$6,515	$52,590
Contract work	$48,381	$5,770	$32,345	$10,266	....	....	....
Miscellaneous expenses	$140,055	$63,990	$34,110	$26,858	$1,900	$536	$12,661
Cost of supplies and materials	$497,949	$156,513	$256,816	$49,408	$2,480	$370	$32,362
Value of product	$2,686,473	$1,500,230	$677,168	$271,270	$51,600	$12,291	$173,914

[1] Includes operators as follows: Graphite, 1; iron ore, 1 (2 mines); lead and zinc, 1; marble, 2; mica, 1; phosphate rock, 1.

Doctor Wizlizenus, writing in 1847, gives a concise presentation of the mineral resources of New Mexico. "In Spanish times several rich mines were worked at Avo, at Cerrillos, and in the Nambe mountains, but none at present. Copper is found in abundance throughout the country, but principally at La Tijera, Jemez, Abiquiu, Guadalupita, etc.; iron, though also abundantly found, is entirely overlooked. Coal has been discovered in different localities, as in the Raton mountains, near the village of Jemez, southwest of Santa Fe, and near, but south of, Placer mountain. Gypsum, both common and selenite, is found in large quantities, extensive layers of it existing in the mountains near Algodones, on the Rio Grande, and in the neighborhood of the celebrated salinas. It is used as common lime for whitewashing, and the crystalline or selenite instead of window glass. About 100 miles south-southeast of Santa Fe, on the high table-land between the Rio Grande and Pecos, are some extensive salt lakes, or salinas, from which all the salt (muriate of soda) used in New Mexico is procured."[1] Very little mining was done by the Americans for many years after their occupation of the territory.[2]

Aside from the minerals commercially produced in 1902, deposits of alum and sulphate of alumina, cinnabar, molybdenum, tungsten, vanadium, and serpentine are known to occur in the territory.

In addition to the productive mining there were 159 operators engaged in developing 159 mines and wells, of the following character: Gold and silver, 156; petroleum, 2; and coal, 1. They gave employment to 358 wage-earners, who were paid $270,896 in wages. Other expenses were contract work, $73,128; miscellaneous expenses, $34,125; and the cost of supplies and materials, $128,488.

The following table shows the value of the products of all the manufacturing industries of the territory, as reported at the census of 1900, and the products of the manufacturing industries which chiefly utilize, as raw materials, the products of mines and quarries:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of products.	
All manufactures		$5,605,795
Based upon the products of mines or quarries:		
Clay, glass, and stone products	$111,698	
Iron and steel and their products	15,546	
Metals and metal products other than iron and steel	1,300,925	
Miscellaneous industries	408,217	
		1,837,486
All other		3,768,309

The manufactured products thus based upon the products of mines and quarries constitute 32.7 per cent of the total value. The value of the mineral production of the territory in 1902 was $2,686,473, or 32.4 per cent of the value of the combined product of manufactures and mines and quarries of the territory. Mines and quarries in 1902 employed 2,275 wage-earners, who were paid $1,646,833 in wages. In 1900 manufactures gave employment to 2,600 wage-earners, who were paid $1,350,586; therefore manufactures gave employment to 53.3 per cent of the wage-earners and paid 45.1 per cent of the wages, while mines and quarries gave employment to but 46.7 per cent of the wage-earners and paid 54.9 per cent of the wages.

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[1] Mineral Resources of the United States, by Browne and Taylor, 1867, page 325.

[2] History of the Pacific Coast States, by Hubert H. Bancroft, Vol. XII, page 748.

The following table, compiled from reports of the United States Geological Survey, shows, with the exception of copper ore, values for which can not be obtained, the value of the annual production of the principal minerals of the territory from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Coal, bituminous.	Gold.[1]	Silver.[1]	Sandstones and quartzites.
1890	$501,390	$850,000	$1,680,808	$186,804
1891	772,018	946,000	1,713,131	50,000
1892	1,074,601	950,000	1,521,390	20,000
1893	979,044	913,100	592,679	4,922
1894	935,857	824,519	276,764	300
1895	1,072,520	492,200	806,320	2,700
1896	900,381	475,800	880,277	(2)
1897	991,611	356,500	697,535	(2)
1898	1,344,750	539,000	549,883	3,500
1899	1,461,865	584,100	650,781	1,829
1900	1,776,179	832,900	[3]269,266	2,500
1901	1,546,652	688,400	[3]338,010	(2)
1902[4]	1,500,230	531,100	[3]212,316	12,291

[1] Estimates of the Director of the Mint, value of refined product, silver at coining value. The values given in Table 1 are the values at the mine.
[2] Not reported separately.
[3] Commercial value.
[4] Census figures except for gold and silver.

Coal, bituminous.—The production of coal in New Mexico was first reported for 1882, when it amounted to 157,092 short tons. It was then mined in Raton, Cerillas, Gallup, Monero, and San Pedro counties, which represent the present counties of Colfax, Santa Fe, McKinley, and Rio Arriba. In addition to these counties coal is now mined in Lincoln, San Juan, San Miguel, and Socorro counties. McKinley and Colfax counties are the heaviest producers, their product being over 74 per cent of the total tonnage of the territory. The coals range from lignite to anthracite, considerable quantities of the latter being found associated with bituminous coal in the Cerillos district.

The following table, compiled from reports of the United States Geological Survey, shows the annual production of coal from 1882 to 1902:

TABLE 4.—*Annual production of coal, bituminous: 1882 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Short tons.	YEAR	Short tons.
1882	157,092	1893	665,094
1883	211,347	1894	597,196
1884	220,557	1895	720,654
1885	306,202	1896	622,626
1886	271,285	1897	716,981
1887	508,034	1898	992,288
1888	626,665	1899	1,050,714
1889	486,943	1900	1,299,299
1890	375,777	1901	1,086,546
1891	462,328	1902	1,048,763
1892	661,330		

Gold and silver.—The Old Placer gold mines, 30 miles southwest of Santa Fe, were discovered in 1828, and were worked to a considerable extent by the Mexicans in the early days. The New Placer gold mines were discovered in 1839.[1] Silver was discovered at Georgetown in 1872.[2] The rich Lake Valley silver mines commenced producing in 1881. The "Bridal Chamber" at Lake Valley, a cavern in the limestone lined with rich silver ores, was one of the most remarkable ore deposits ever found. It was here that Governor Safford offered $50,000 for the ore he could extract unaided in ten hours.[3]

The decade 1880 to 1889 witnessed a large increase in the gold and silver production, as shown by the following table, compiled from the reports of the Director of the Mint:

TABLE 5.—*Annual production of gold and silver: 1880 to 1889.*

[Reports of the Director of the Mint.]

YEAR.	Gold.	Silver.[1]	YEAR.	Gold.	Silver.[1]
1880	$49,354	$372,337	1885	$800,000	$3,000,000
1881	185,000	275,000	1886	400,000	2,300,000
1882	150,000	1,800,000	1887	500,000	2,300,000
1883	280,000	2,845,000	1888	602,000	1,200,000
1884	300,000	3,000,000	1889	1,000,000	1,161,000

[1] Coining value.

Copper.—Two copper mines were extensively worked before the Civil War—the Santa Rita and the Hanover—turning out about 12 tons of copper per week and employing jointly about 500 hands.[4] The Santa Rita mines, near Silver City, were discovered by Lieutenant-Colonel Carrisco in 1800,[5] and were extensively worked for copper, much of it native, before the Gadsden Purchase.[6]

TABLE 6.—*Annual production of copper: 1882 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Pounds.	YEAR.	Pounds.
1882	869,498	1893	280,742
1883	823,511	1894	31,984
1884	59,450	1895	143,719
1885	79,839	1896	2,701,664
1886	558,385	1897	701,992
1887	293,664	1898	1,592,371
1888	1,631,271	1899	5,935,441
1889	3,686,137	1900	4,169,490
1890	850,034	1901	9,629,884
1891	1,293,107	1902	6,614,961
1892	1,188,796		

Precious stones.—The production classified as precious stones consists of turquoise, from Grant and Otero counties, and garnets, from McKinley county. The value of the turquoise product in 1902 was $51,100, of which $47,600 was from the mines of Grant county and $3,500 from Otero county. The garnets from McKinley county were found by individuals, and were not from any regularly operated mine.

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[1] Harper's Encyclopedia, Vol. IX, page 449.
[2] The Mineral Industry, 1892, Vol. I, page 220.
[3] History of the Pacific Coast States, Vol. XII, page 755.
[4] Mineral Resources of the United States, 1867, page 325.
[5] Harper's Encyclopedia, Vol. IX, page 448.
[6] The Mineral Industry, 1894, Vol. III, page 247.

The most interesting of the ancient turquoise workings are in the Chalchuitl mountain ("Chalchuitl" is the Indian name for turquoise). The entire hill is undermined by caves, and there are two immense open cuts, the larger being over 300 feet across and 200 feet or more in depth. According to tradition, a great rock slide occurred here in 1680 that buried some twenty-five Indians. The requisition of the Spaniards on the neighboring pueblo of San Marcos for more Indians to take the place of those entombed led to a general uprising, that resulted in driving the Spaniards out of the country.

Modern turquoise mining in New Mexico has been developed since the census of 1890. There are three districts where turquoise is produced—the ancient turquoise mines in the Cerrillos mining district, 18 miles south of Santa Fe, a locality in the vicinity of Cow Springs mountain and Burros, and the mines opened a few years ago in the Jarilla district, in Otero county. In opening the old workings of the ancient mines stone hammers and pottery in considerable quantities were found.[1]

For the decade from 1890 to 1900 the total output of the largest turquoise mine at Cerrillos amounted to more than $2,000,000 in value. A single stone has been sold for as much as $3,000.

Pyrope garnets, sometimes called Arizona rubies, are found on the Navajo reservation. An interesting variety of green semiopal has been discovered in Taos county.

Sandstones and quartzites.—Sandstone quarries are operated in Bernalillo, Colfax, and San Miguel counties, chiefly for building stone. In the vicinity of Las Vegas, Hot Springs, and Albuquerque occur beds of light gray, brown, and pink sandstone of fine texture.[2]

All other minerals.—Amorphous graphite is found in the Raton mountains. The total graphite production of the territory was refined graphite from one establishment, an incorporated company, operating in Colfax county.

One individual operator worked two iron mines in 1902 in Grant county. The deposits of iron ore in the territory are numerous, extending from the Raton mountains to the Placer and Sandia mountains. Ore of excellent quality is found near Las Vegas. At the Hanover copper mine there is a heavy supply of iron ore, partly magnetic and partly a red hematite. On the Rio Puerco, associated with coal, occur frequent bands of iron ore. East of the Gallinas range and about 30 miles west of Socorro, in Socorro county, there is a large tract of land covered with iron nodules that have been shipped in large quantities for use as flux in smelters. Good iron ore occurs also in the Santa Rita, Burros, and other ranges in the southern part of the territory.[3]

Marble was quarried in 1902 at two quarries in Otero county. Near the Rio Puerco station of the Atlantic and Pacific Railroad, in Valencia county, are deposits of travertine, or stalagmitic matter, thus far exploited only in a preliminary way. The stone varies in color from almost white to almost black, and from translucent to opaque. The better varieties show, when polished, a silky luster and a radiated fibrous structure.[4] White and black marble occurs in the White Oaks district, Lincoln county.

Mica was obtained from one mine in Taos county. It has also been worked to some extent in the Cribbenville district, Rio Arriba county.[5] Phosphate rock was reported for the first time as mined to a small extent in Luna county.

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[1] Report of the Governor of New Mexico, 1901, page 405.

[2] Stones for Building and Decoration, by George P. Merrill, page 149.

[3] United States Geological Survey, "Mineral Resources of the United States," 1883, page 285.

[4] Stones for Building and Decoration, page 274.

[5] The Mineral Industry, 1898, Vol. VII, page 510.

NEW YORK.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in New York state for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Cement.	Limestones and dolomites.	Petroleum.	Sandstones and quartzites.	Iron ore.	Siliceous crystalline rocks.	Talc and soapstone.
Number of mines, quarries, and wells	9,768	21	181	8,443	377	15	22	4
Number of operators	2,921	20	178	2,123	364	13	22	4
Salaried officials, clerks, etc.:								
Number	791	141	174	69	86	62	47	29
Salaries	$798,382	$160,282	$166,459	$92,116	$67,463	$65,231	$42,942	$19,654
Wage-earners:								
Average number	9,560	2,459	2,422	108	1,284	965	655	163
Wages	$5,099,758	$1,203,313	$1,211,742	$296,713	$785,694	$432,009	$357,329	$93,690
Contract work	$356,113	$4,150		$272,759				
Miscellaneous expenses	$1,276,232	$310,772	$142,206	$259,740	$104,193	$199,587	$29,157	$38,796
Cost of supplies and materials	$3,002,554	$1,374,640	$151,876	$140,008	$108,159	$293,960	$94,299	$15,253
Value of product	$13,350,421	$3,656,539	$2,603,586	$1,530,852	$1,408,609	$1,362,987	$651,014	$615,350

	Marble.	Natural gas.	Gypsum.	Slate.	Garnet.	Graphite.	Corundum and emery.	Buhrstones and millstones.	All other minerals.[1]
Number of mines, quarries, and wells	14	612	17	11	3	8	3	22	20
Number of operators	13	108	15	11	3	5	3	22	19
Salaried officials, clerks, etc.:									
Number	34	76	22	17	7	7	5	6	10
Salaries	$40,644	$63,015	$32,600	$14,645	$6,050	$5,627	$2,349	$3,740	$4,575
Wage-earners:									
Average number	469	121	211	126	83	71	2	59	52
Wages	$332,066	$84,476	$100,998	$69,561	$47,093	$55,588	$1,446	$28,021	$23,961
Contract work		$77,904							
Miscellaneous expenses	$31,263	$127,530	$11,081	$8,429	$3,200	$1,124	$2,171	$849	$2,824
Cost of supplies and materials	$100,708	$79,920	$31,175	$16,225	$8,300	$19,543	$2,575	$1,499	$4,541
Value of product	$577,298	$346,471	$259,170	$126,718	$97,600	$77,437	$44,625	$39,570	$52,505

[1] Includes operators as follows: Clay, 7 (8 mines); crystalline quartz, 1; feldspar, 1; flint, 2; infusorial earth, tripoli, and pumice, 1; lead and zinc ore, 1; mineral pigments, crude, 5; sulphur and pyrite, 1.

The mineral resources of the state are varied, 23 different minerals contributing to the state's output in 1902. Among the various branches of the mining industry in the state the manufacture of cement is foremost. Both natural rock and Portland cement are produced in large quantities; and New York has led the states for many years in the production of natural rock cement. The greater part of the crystalline graphite production in the United States comes from the mines at Ticonderoga, in Essex county, where the mineral has been mined for nearly a century. The gypsum deposits of the state are extensive, and in gypsum mining New York ranks fourth. The glass sand found in the state occurs in a form sufficiently disintegrated to require no further crushing before using it in the manufacture of glass.[1] The corundum and emery mines near Peekskill are among the largest producers of these abrasive materials in the United States, and in the production of garnet for abrasive purposes the state ranks high. Most of the buhrstones made in the United States are from the quarries of the state along the eastern slopes of the Appalachian mountains. The state for many years has been a large producer of fibrous talc, most of which is used in paper making. Extensive deposits of clays are widely scattered and many of them are capable of being used in the manufacture of terra cotta, roofing tile, and the coarser grades of pottery.[2] Natural gas is also found over a very large area of the state. It was first used as a source of light and heat at Fredonia, Chautauqua county, in 1821.[3] The oil territory in New York is a continuation of the Bradford, Pa., field and has been more or less productive since 1865.[4] With the exception of Pennsylvania, New York state is the largest producer of the magnetite variety of iron ore, which abounds in the Highlands of the Hudson and in the Adirondack region, where the ore has been mined, for over a century in the Lake Champlain valley.[1] Iron ores of both the red and brown hematite variety are also mined in the state, and in a number of localities ore of the hematite variety is found suitable for metallic paint, and is also used for coloring matter in making mortar.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 1010.

[2] New York State Museum, Bulletin No. 12, page 98.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 648.

[4] New York State Museum, Bulletin No. 15, page 558.

The numerous quarries of the state produce annually large and valuable quantities of fine stones, among which are included the granite of the Adirondack region, the sandstones of Potsdam and Medina, the bluestone of the Hudson valley, the shell limestone of Lockport, the black marble of Glens Falls, the red marble of Warwick, the verd antique of Moriah, the roofing slate of Washington, Rensselaer, and Columbia counties, and the white marble of Westchester.[2]

Other minerals mined or quarried in the state in greater or less quantities are crystalline quartz, feldspar, flint, infusorial earth, lead and zinc ore, and sienna.

The following minerals also occur in the state, but were not produced in commercial quantities in 1902: Barytes, chrysoberyl, copper, fluorite, ilmenite, manganese, molybdenum, monazite, nickel, pyrope, rutile, serpentine, strontium ore, whetstones, mica, tourmaline, and sulphur and pyrite.

In addition to the productive mines, quarries, and wells shown in Table 1, 6 operators reported mines and quarries having no production, the work done during 1902 being confined to development and care. These operators gave employment to 96 wage-earners on an average during the year and paid $50,403 in wages. The 11 salaried officials, clerks, etc., received $16,569; the contract work amounted to only $500; the miscellaneous expenses were $6,131; and the cost of supplies and materials was $2,164.

The following table shows the value of the products of manufacturing industries based primarily upon minerals mined or quarried, as well as the value of all manufactured products of the state as reported at the census of 1900:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of products.	
All manufactures		$2,175,726,900
Based upon products of mines or quarries:		
Chemicals and allied products	$58,870,669	
Clay, glass, and stone products	42,591,874	
Iron and steel and their products	157,050,481	
Metals and metal products, other than iron and steel	93,341,219	
Miscellaneous industries	140,847,282	
		492,701,525
All other		1,683,025,375

The value of the manufactured products, based primarily upon minerals mined and quarried, as shown by the foregoing table, amounted to $492,701,525, or 22.6 per cent of the total value of all manufactures in the state as reported for 1900. The value of the output of the mines, quarries, and wells of the state in 1902, $13,350,421, was six-tenths of 1 per cent of the total value of all the manufactures of 1900, and the products of mining and quarrying in 1902.

The wage-earners employed during the census year 1900 by the manufacturing industries of New York state numbered 849,056, and the wages paid amounted to $408,855,652. The operators of the mines, quarries, and wells of the state reported that they employed, during 1902, 9,560 wage-earners and paid $5,099,753 in wages. Manufactures and mining together gave employment during the year to 858,616 wage-earners and paid $413,955,405 in wages. Manufactures, therefore, employed 98.9 per cent of the wage-earners and paid 98.8 per cent of the wages, and mines and quarries gave employment to but 1.1 per cent of the wage-earners and paid 1.2 per cent of the wages.

The following table presents the value of the annual production of the leading minerals of the state from 1890 to 1902:

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[1] New York State Museum, Bulletin No. 15, pages 520 to 535.
[2] King's Handbook of the United States, page 589.

TABLE 3.—VALUE OF ANNUAL PRODUCTION OF PRINCIPAL MINERALS: 1890 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	CEMENT.[1]		Limestones and dolomites.	Petroleum.	Sandstones and quartzites.	Iron ore.	Siliceous crystalline rocks.	Talc and soapstone.	Marble.	Natural gas.	Gypsum.	Slate.
	Portland.	Natural rock.										
1890	$110,000	$2,985,513	$1,708,830	(2)	$702,419	(2)	$222,775	$589,190	$550,197	$552,000	$71,068	$125,040
1891	190,250	3,016,279	1,200,000	$1,061,970	400,000	(2)	225,000	493,068	500,000	280,000	58,571	176,000
1892	279,000	3,074,781	1,250,000	708,297	450,000	$2,679,297	200,000	472,485	380,000	216,000	61,100	210,000
1893	287,725	2,866,387	1,103,529	660,000	115,518	1,222,934	181,120	505,426	206,926	210,000	68,292	201,982
1894	205,231	1,974,163	1,378,861	790,464	170,992	298,156	110,018	415,060	301,585	249,000	60,252	11,512
1895	278,810	2,285,000	1,013,182	1,240,468	115,941	298,333	68,471	470,897	305,828	241,500	52,321	91,875
1896	443,175	2,428,891	1,591,966	1,420,653	225,175	780,932	161,167	389,443	481,100	256,000	32,812	82,422
1897	690,197	2,125,771	1,697,780	1,000,236	541,424	642,838	422,216	396,936	574,684	209,076	78,684	54,799
1898	970,125	2,105,658	1,533,996	1,098,284	466,153	350,999	516,847	411,450	342,072	229,078	81,908	18,024
1899	708,579	2,813,900	1,545,699	1,708,925	1,218,063	1,241,985	306,711	438,150	328,816	294,593	116,533	76,075
1900	582,290	2,095,461	1,730,162	1,760,501	1,167,484	1,103,817	446,171	499,500	282,518	335,367	150,588	62,775
1901	617,228	1,117,066	1,738,716	1,640,078	1,291,327	1,006,231	459,828	483,600	579,120	293,232	241,049	100,920
1902	(4)	3,656,589	2,563,536	1,520,852	1,408,099	1,362,987	651,014	615,350	677,258	346,171	250,176	129,758

[1] Values of Portland cement previous to 1891, and of natural rock cement previous to 1896 include cost of packages.
[2] Value not reported.
[3] Census figures.
[4] Included in natural rock cement.

Cement.—New York, which leads the states in the manufacture of the Rosendale, or natural rock cement, is also the state in which the industry in this country was first established. Natural-cement rock was first discovered in this country about 1818 at or near Chittenango, Madison county, N. Y., and was first used in the construction of the Erie canal.[1] In 1823, when the Ulster county section of the Delaware and Hudson canal was under construction, hydraulic-cement rock was discovered near Rosendale.[2] In 1825 a rock similar to the Chittenango variety was discovered at Highfalls, in Ulster county, and the first crushing mill was erected there in 1826. In 1828 a mill was built at Rosendale, in Ulster county. This locality soon became the leading center for this industry, and has so remained.[3] Extensive works were also erected at Whiteport and at other places in the vicinity.

Upon the completion of the canal activity in the manufacture of cement greatly declined, but upon the reopening of the old Snyder mill interest revived and the natural rock cement was made for the general market. Since 1839, when an exceptionally high grade of cement rock was found at Akron, in Erie county, an increasing industry has been maintained in that region.[3]

Certain strata of limestone were found near South Rondout, Ulster county, that are well adapted to the manufacture of Portland cement, and suitable clay for its production was also found near Phoenicia, in the same county.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of both Portland and natural rock cement from 1890 to 1902:

TABLE 4.—*Annual production of cement: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Portland (barrels).	Natural rock (barrels).	YEAR.	Portland (barrels).	Natural rock (barrels).
1890	65,000	3,766,756	1897	394,398	4,259,186
1891	87,000	3,931,306	1898	554,358	4,157,917
1892	124,000	3,780,687	1899	472,386	4,689,167
1893	137,096	3,597,758	1900	465,832	3,409,085
1894	117,275	3,446,330	1901	617,228	2,234,131
1895	159,320	3,939,727	1902	1,156,807	3,577,340
1896	260,787	4,181,918			

In 1902 a total of 21 plants in the state were making cement, 11 of which manufacturing natural rock cement only, 8 making Portland cement only, and 2 making both. The total output was 4,734,147 barrels, valued at $3,656,589. Of this output 3,577,340 barrels were natural rock cement and 1,156,807 Portland cement. Ulster county alone produced 2,730,750 barrels of natural rock cement, or 76.3 per cent of the total for the state.

Limestones and dolomites.—The limestones in the state that furnish building stone belong to the following named formations: Calciferous, which may be traced along the Mohawk valley, in Herkimer, Montgomery, and Oneida counties; the Chazy, seen in Clinton county in its typical development and in the Champlain valley; the Trenton, found in Montgomery, Fulton, Herkimer, Oneida, Lewis, Jefferson, St. Lawrence, Hamilton, Clinton, Essex, Warren, and Saratoga counties; the Niagara, which has its greatest development near the Niagara river; the Lower Helderberg, found in the Rondout valley and in Ulster, Greene, Herkimer, and Otsego counties; the Upper Helderberg, found in Onondaga, Cayuga, Seneca, Monroe, Genesee, Erie, and Ulster counties; and the Tully, found in Onondaga county. A stratum of Lower Silurian limestone, 60 to 70 feet in thickness, is extensively worked for ornamental and building purposes at Greenport, Columbia county. It is a stone of medium texture, semicrystalline, highly fossiliferous, of a water-blue or gray color, and has been known as "coal-shell marble." In various towns in Montgomery county a gray or blue-gray semicrystalline limestone is quarried for building material.[4] The Onondaga gray limestone is well developed and is extensively quarried in Onondaga county. The Upper Helderberg beds at Auburn, Cayuga county, have furnished gray and blue-gray magnesian limestone since 1810, when the first quarry was opened. The Lockport gray limestone has been quarried in Niagara county along the Erie canal since 1825.[5]

The 181 quarries from which a production was reported in 1902 were located in 34 counties, and had an aggregate output valued at $2,503,536, New York thus taking fifth place among the states in the production of limestone. The increase over 1901 amounted to $764,820. The value of the limestone quarried for building purposes in 1902 amounted to $480,141.

Petroleum.—The occurrence of petroleum in New York state was first recorded by a Jesuit missionary who visited the oil spring at Cuba, Allegany county, in 1627. The Indians valued the oil from this spring for its supposed curative powers when externally applied, and it became widely known as "Seneca oil."[6] The oil territory in the state is a continuation of the Bradford field of Pennsylvania, and almost all the developed territory in the state is contained in Cattaraugus and Allegany counties, in the southwestern part of the state. The first drilling was done at Limestone, in Cattaraugus county, in 1865. In 1881 a well was drilled at

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 797 to 799.

[2] The Mineral Industry, 1897, Vol. VI, page 92.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 799.

[4] Stones for Building and Decoration, by George P. Merrill, pages 315 to 318.

[5] New York State Museum, Bulletin No. 15, pages 443 to 447.

[6] Ibid., pages 557 and 558.

Petrolia, in Allegany county, and a year later another was drilled at Richburg, in the same county. The oil varies in color from light yellow to almost black, although the dark green oil is by far the most abundant.[1]

In 1902 there were 8,443 producing wells, with an output of 1,119,730 barrels, valued at $1,530,852. This was a decrease in production of 86,888 barrels as compared with 1901.

The following table, compiled from the reports of the United States Geological Survey, shows the annual petroleum production of the state from 1891 to 1902:

TABLE 5.—*Annual production of petroleum: 1891 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1891	1,585,030	1897	1,279,155
1892	1,273,343	1898	1,205,250
1893	1,031,391	1899	1,320,909
1894	942,431	1900	1,300,925
1895	912,948	1901	1,206,618
1896	1,205,220	1902	1,119,730

Sandstones and quartzites.—The principal sandstones quarried in New York state may be divided into three groups, belonging respectively to three distinct geological horizons, and each group having its peculiar characteristics.[2]

The first group, popularly known as "bluestone," belongs to the Hamilton period of the Devonian formations. The stones are fine grained, compact, dark blue-gray stones, very strong and durable.[2] The area in which bluestone is quarried in the state extends from the west shore of the Hudson river, in Albany, Greene, and Ulster counties, in a southwesterly direction to the Delaware river, through Delaware and Sullivan counties. There is also a small isolated region of production in Chenango county.[3]

The second group belongs to the Medina period of the Upper Silurian formations. The stones are largely siliceous, of coarser, more distinctly granular texture than the bluestone, and are gray or red in color. Quarries of Medina sandstone are found in Oswego, Oneida, Cayuga, Wayne, Monroe, Orleans, and Niagara counties. The stone has been quarried at Lockport, in Niagara county, since 1824.[4] This stone has a wide use for street paving, in place of the usual granite or trap blocks.[5]

The third group belongs to the Potsdam period of the Cambrian formations, the oldest formation in which sandstone is quarried for building purposes in the state. The Potsdam sandstone is quarried in Jefferson, Franklin, Essex, Washington, and St. Lawrence counties. The most extensive openings are near Potsdam, in St. Lawrence county, the stone being hard, compact, and even grained, and pink to red in color. Some of it has a laminated structure and striped appearance. It is an excellent building stone, and is widely known and esteemed for its beauty and durability.[5]

The value of the sandstone quarried in the state in 1902 at the 377 productive quarries amounted to $1,408,699, an increase over 1901 of $77,372. The value of the stone quarried for building purposes amounted to $550,039; for paving, $264,858; for curbing, $272,831; and for flagstones, $230,158. The productive quarries were located in 31 counties; Orleans ranking first in value of product.

Iron ore.—Albany, Cayuga, Clinton, Columbia, Dutchess, Essex, Franklin, Herkimer, Jefferson, Lewis, Madison, Oneida, Onondaga, Orange, Putnam, Richmond, Rockland, St. Lawrence, Saratoga, Warren, Washington, Wayne, and Westchester counties are known to contain one or more of the varieties of iron ore found in the state, and in most of these counties iron ore has been mined at one time or another.[6]

Although iron ore was found in various places by the Dutch during their rule from 1614 to 1664, no known effort was made by them to manufacture iron, and it is not probable that any mining of iron ore of consequence was then attempted. The first known ironworks in the state were established in Columbia county, near the Connecticut line, about 1740, but the ore was mainly obtained from the Salisbury mine in Litchfield county, Connecticut.

With the discovery of the celebrated Sterling mine, near Monroe, in Orange county, in 1750, and the building of a furnace in that locality in the succeeding year, iron ore mining in New York state may be said to have really begun.[7] The Forest-of-Dean mine, 5 miles west of Fort Montgomery, in Orange county, was discovered about the same time.[8]

Historic interest attaches to the Sterling group of mines, not only because here was probably the first iron mine opened in the state but also because the anchors for the United States frigate *Constitution*, and the great iron chain suspended across the Hudson river at West Point in 1778 to prevent the passage of the British vessels, were made at the Sterling Iron Works from ores produced at these mines.[7]

The Maltby mine, near Millerton, in Dutchess county, opened in 1750, has produced a large amount of ore, and much of it was smelted in a furnace on the property.[9] The Armenia mine, in Dutchess county, opened about 1760, was still worked in 1902. During the Revolution the ore from this mine was used for making guns.[1] The output from the Dutchess county iron ore mines at the present time is comparatively small.

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[1] New York State Museum, Bulletin No. 15, pages 557 and 558.
[2] Stones for Building and Decoration, pages 150 to 153.
[3] New York State Museum, Bulletin No. 15, page 411.
[4] Ibid., page 400.
[5] Ibid., pages 383 and 384.
[6] Mineralogy of New York, 1842, by Lewis C. Beck, pages 5 to 35.
[7] Iron in All Ages, by James M. Swank, pages 136 and 140.
[8] New York State Museum, Bulletin No. 7, page 6.
[9] Ibid., page 58.

Iron ore was mined and furnaces were erected in Westchester county before the close of the eighteenth century, and iron mines were also worked in Putnam county about the same time.[1] The Tilly Foster mine is located near Brewster, in Putnam county. Neither Westchester nor Putnam county reported production in 1902.

About 1800 the celebrated Champlain iron district, comprising the counties of Essex, Clinton, and Franklin, was developed,[1] one of the oldest openings in Essex county being the Castaline bed, near Elizabethtown.[2] The output during the earlier years of the development was small, aggregating but a few thousand tons, but it increased rapidly after 1840, and in 1868 the town of Moriah alone produced 230,000 tons.[3] With the further development of the Port Henry and Chateaugay mines this district was and is to-day the leading iron ore producing district in the state.[4]

The Caledonia mine at Rossie, St. Lawrence county, was opened in 1812, the Kearney in 1825, and the Keene in 1837. These mines produced ore of the red hematite variety.[5] The Old Sterling mine, near Antwerp, in Jefferson county, first opened in 1836, is another mine that produces red hematite ore.[6] This mine was in operation in 1902.

The Clinton, or fossil, ores have been found in Herkimer, Oneida, Madison, Cayuga, Wayne, and Monroe counties, but very little mining has been done except in the towns of Clinton, in Oneida county, and Ontario, in Wayne county. The first lease for digging Clinton ore was given in 1797.[7]

In 1902 there were 15 productive iron mines in the state, in Clinton, Dutchess, Essex, Herkimer, Jefferson, Lewis, Oneida, Orange, St. Lawrence, and Wayne counties. The total production was 555,321 long tons, valued at $1,362,987. Essex county alone produced 324,731 tons. Magnetic ore was produced in Essex, Clinton, Herkimer, Lewis, and Orange counties; red hematite in Jefferson and St. Lawrence counties; fossil in Wayne and Oneida counties; and brown hematite in Dutchess county.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of iron ore in New York state from 1884 to 1902:

TABLE 6.—*Annual production of iron ore: 1884 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Long tons.[1]	YEAR.	Long tons.
1884	651,228	1894	242,759
1885	471,261	1895	307,256
1886	699,480	1896	385,477
1887	919,764	1897	335,725
1888	738,902	1898	179,951
1889	1,247,537	1899	443,790
1890	1,253,393	1900	441,485
1891	1,017,216	1901	420,218
1892	891,099	1902	555,321
1893	534,122		

[1] Quantities reported for the first five years represent the output of the leading districts.

Siliceous crystalline rocks.—Although massive crystalline rocks are of common occurrence in the state, they do not outcrop over extensive areas, excepting in the Adirondacks and in the Highlands of the Hudson. Gneissic rocks have been quarried at many points within the city limits of New York. In Westchester county there are belts of gneiss and mica schist. Granite quarries have been opened in Putnam, Orange, and Rockland counties.[8]

Probably the most important of the true granites of the state for monumental work is the red variety quarried in various places on Grindstone Island, Jefferson county, in the St. Lawrence river. The stone is deep red and coarsely crystalline, taking a high lustrous polish.[9]

In 1902 granite was quarried in Clinton, Fulton, Herkimer, Jefferson, Orange, Putnam, Richmond, Rockland, St. Lawrence, and Westchester counties. The 22 productive quarries had an output valued at $651,014, of which Westchester county was credited with $302,526. The value of the granite, both rough and dressed, quarried for building purposes was $307,453, and of that dressed for monumental work was $7,180.

Talc and soapstone.—The fine deposits of soapstone in the vicinity of Gouverneur, in St. Lawrence county, attracted the attention of a mineralogist prospecting in that county during the seventies. Later, attention was directed to the rich deposits of foliated talc in the town of Fowler, but it was found that the material was not suitable for the uses contemplated. About this time workmen engaged in roadmaking in the vicinity of Gouverneur found a large vein of fibrous talc, the first of this variety discovered which, when pulverized, was found to be a suitable material for weighting and finishing paper. Prospecting was carried on, new mines were opened, and new mills erected, and by 1893 every available water privilege from Taleville down the Oswegatchie to a point below Gouverneur was occupied by a milling establishment devoted to the production of pulverized talc.[1]

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[1] Iron in All Ages, pages 141 and 142.

[2] New York State Museum, Bulletin No. 7, pages 34 and 35.

[3] Ibid., page 9.

[4] Ibid., pages 9 and 33.

[5] Ibid., page 47.

[6] Ibid., page 45.

[7] Ibid., pages 11 and 12.

[8] New York State Museum, Bulletin No. 15, page 374.

[9] Stones for Building and Decoration, pages 78 and 79.

All the mines that have been developed are found on a comparatively narrow ridge, about 7 miles long, the most valuable deposits being in the immediate vicinity of Taleville. Here the best beds are of unknown depth and extent. In most of the mines to the south of Taleville the fibrous material is too largely mixed with the foliated talc to be valuable. At the Freeman mine active operations are carried on 300 or 400 feet below the surface, the deposit being of vein form and having well-defined granitic walls. The material as it comes out in the form of slabs is easily split in the direction of the fiber, but is quite refractory across the grain. The slabs have a pure, pale, sea-green tint, while the manufactured product is snow-white. The principal use of fibrous talc is in filling and weighting paper, but it is also used as an adulterant in certain drugs and as a mixer in cheap grades of soap.[1]

In 1902 there were 4 productive mines in St. Lawrence county, the total output being 71,100 short tons, valued at $615,350.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of fibrous talc in the state from 1880 to 1902:

Table 7.—*Annual production of talc and soapstone: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1880	4,210	1892	41,925
1881	5,000	1893	35,861
1882	6,000	1894	39,906
1883	6,000	1895	39,240
1884	10,000	1896	46,089
1885	10,000	1897	57,009
1886	12,000	1898	54,356
1887	15,000	1899	54,655
1888	20,000	1900	63,500
1889	23,746	1901	69,200
1890	41,354	1902	71,100
1891	53,054		

Marble.—Crystalline limestones occur in New York city and in Westchester county, in the Highlands of the Hudson, and in the Adirondack region. Quarries opened in Westchester, Putnam, and Dutchess counties have yielded a large amount of fine white marble.

Marble has been taken from quarries at Tuckahoe, in Westchester county, since 1820.[2] The stone is pure white in color and somewhat irregular in quality, but the better grades are highly esteemed for architectural purposes and have been used in some of the finest buildings in New York city.[3]

The Gouverneur marble, in St. Lawrence county, is a very coarsely crystalline light gray magnesian limestone, which although too coarse for carved work is suitable for massive structures. It is also used largely for monuments, as well as for building and ornamental work, because it retains a good surface and polish and is believed to be durable.[3]

In the Lower Silurian formation at Plattsburg and Chazy, in Clinton county, two excellent varieties of colored marbles occur, which are commercially known as "Lepanto" and "French gray." The French gray has been used more extensively, with the possible exception of the Tennessee marble, than any other domestic marble for mantels, table tops, tiling, and general interior decorative work.[3]

At Glens Falls, in Warren county, there is an extensive deposit of dark blue-black magnesian limestone, certain strata of which furnish the finest varieties of black marble at present quarried in this country. The stone is very fine grained and compact, and when polished is a deep, lustrous black in color, though the uniformity of the color is sometimes broken by the presence of a small white fossil.

A beautiful coarsely crystalline marble of a carmine-red color, sometimes slightly mottled or veined with white, is found at Warwick, in Orange county. This stone has been but little used, and the supply reported is small.

A peculiar granular stone, consisting of an intimate mixture of serpentine, dolomite, and calcite, interspersed with small flecks of phlogopite, has been quarried at Moriah and Port Henry, in Essex county, under the name of ophite marble. This stone is nearly free from the numerous dry seams and joints that prove so objectionable in most serpentines, and it can be obtained in sound blocks of fair size. The stone polishes well and is said to be durable. A stone of the same general nature has been quarried near Thurman,[1] in Warren county, and it occurs elsewhere in the same county.

The largest and most valuable deposit of serpentine in the state is at Gouverneur, Fowler, and Edwards, in St. Lawrence county. The rock is massive and sound and remarkably free from the defects usually developed in rocks of this class. Near Pitcairn, in the same county, there is a fine deposit of serpentine of the variety commonly called precious, and serpentine, from almost black to nearly white, forms the main range of hills on Staten Island.[2]

The producing marble quarries of the state in 1902 numbered 14, and were located in Clinton, Columbia, Dutchess, St. Lawrence, Warren, and Westchester counties. The value of the marble quarried amounted to $577,298, an increase over 1901 of $198,139. Of the total, $267,013 was the value of the marble dressed for building, while that dressed for monumental work was valued at $143,080.

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[1] The Mineral Industry, 1893, Vol. II, pages 603 to 606.

[2] New York State Museum, Bulletin No. 15, pages 425 to 432.

[3] Stones for Building and Decoration, pages 218 to 220.

[1] Stones for Building and Decoration, page 367.

[2] Ibid., page 368.

Natural gas.—Over a very large area in the western part of the state natural gas is found in a number of different sandstones and limestones. Along the southern shores of Lake Ontario and Lake Erie are scattered a vast number of small wells, each furnishing gas to from one to four families.

In 1902 there were 612 productive gas wells in the state, producing an output valued at $346,471, an increase of $53,199 over 1901.

Gypsum.—The gypsum deposits extend in a narrow belt through the central part of the state in Madison, Onondaga, Cayuga, Ontario, Monroe, Livingston, and Genesee counties. The bed near Union Springs, in Cayuga county, was first opened in 1828.[1] In a number of places the industry is only of local importance, the product being used exclusively for land plaster, but there are some large plants which produce principally wall plaster.

In 1902 the 17 productive plants produced 95,318 short tons, of which 60,184 was calcined into wall plaster and plaster of Paris. The entire product was valued at $259,170; that calcined into wall plaster at $200,236. The state ranked fourth among the states in the production of this mineral.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of gypsum in New York state from 1889 to 1902:

TABLE 8.—*Annual production of gypsum: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1889	52,608	1896	23,325
1890	32,906	1897	33,440
1891	30,135	1898	31,655
1892	32,394	1899	32,149
1893	36,126	1900	58,890
1894	31,798	1901	119,565
1895	33,587	1902[1]	110,364

[1] Census reports 95,318 tons of gypsum products.

Slate.—Roofing slate has been found in many localities in the state and quarries have been opened in Orange, Dutchess, Columbia, Rensselaer, and Washington counties. The only productive slate quarries, however, are in a narrow belt lying entirely within Washington county. The stone varies in color from red and purple to green and is of excellent quality.[2]

The 11 quarries productive in 1902, all in Washington county, had an output valued at $126,718—an increase of $25,758 over 1901.

Garnet.—This mineral is found in Warren county, on the borders of the Adirondack region, and in Essex and St. Lawrence counties. The entire deposits in Warren county appear to be of the common variety, almandine. It occurs in a formation of crystalline limestone and in gneissic rocks which adjoin or are intercalated with the crystalline limestone. Commercially this mineral is classified as massive garnet, shell garnet—the most valuable for industrial purposes on account of its purity—and pocket garnet.[3] The garnet is used almost exclusively in the manufacture of sandpaper, or garnet paper, which is used for abrasive purposes by manufacturers of boots and shoes and by wood manufacturers.

In 1902 garnet was mined commercially in Essex, Warren, and St. Lawrence counties, but the work done in St. Lawrence county was more or less experimental. The total production for the state in 1902 was 2,760 tons, valued at $97,600. As the total output of garnet in the United States for 1902 was 3,926 tons, valued at $132,820, New York state produced 73.5 per cent in value of the entire product shown for the country.

Graphite.—Deposits of graphite are known to exist throughout the Adirondack region, but the mining of crystalline graphite in this portion of the state has been practically confined to a comparatively small section in the southeast portion of Essex county and in the northeast part of Warren county.[4] There are also occurrences of graphite in Dutchess county and several tons have been obtained from them.[5]

The material in the mines near Ticonderoga, in Essex county, is in a vein of the purest foliated graphite, several inches in width. The folia often have a radiated arrangement and are of considerable size. The gangue is calcareous spar, which sometimes exhibits large and perfect cleavages. At Johnsburg, in Warren county, the mineral occurs in irregular shaped masses, weighing from 1 to 20 pounds, in a vein of quartz.[5]

Early in the last century, after the accidental discovery in 1815 of a deposit at Ticonderoga, in Essex county, graphite mining was carried on, in a primitive manner, by the farmers owning the land, and the material, ground with considerable magnetic iron ore, was used for stove blacking.[4]

In 1830 the invention of the lead pencil aroused increased interest in the Essex county mines. New openings were made in the mountain side and pencil leads were made from the crude graphite in the vicinity of the mines. In 1863 the American Graphite Company acquired these properties, an extensive mill was erected, and the industry increased so rapidly that the annual production reached 500 tons in 1869. Subsequently the same company acquired the Warren county properties.[4]

In 1902 the three productive mines of the state, located in Essex and Warren counties, produced 1,375 tons of crystalline graphite, valued at $77,437. As the total quantity of this mineral mined in the United States in 1902 was 1,983 short tons, the contribution of New York state was 69.3 per cent of the whole.

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[1] New York State Museum, Twentieth Report of the State Geologist, 1900, page r180.

[2] New York State Museum, Bulletin No. 15, pages 421 and 422.

[3] New York State Museum, Bulletin No. 15, pages 553 and 554.

[4] Private Historical Notes on the Graphite Deposits of Essex and Warren Counties, New York, by H. P. Whitlock, under the direction of Mr. F. J. H. Merrill, geologist of New York state.

[5] Mineralogy of New York, pages 97 and 98.

Corundum and emery.—The emery mines of the state are located in Westchester county, near Peekskill. In most cases they are abandoned iron mines, emery not having been recognized when iron ore was being mined in this region. As the emery outcrops on the hillsides, the mines are usually shallow openings or quarries.[1]

The output of the 3 mines productive in 1902 was 2,886 tons, or 67.9 per cent of the production of corundum and emery for the United States. The value of the New York emery was $44,625.

Buhrstones and millstones.—In the United States the millstone varies from a sandstone to a quartz conglomerate. The rock from which it is made occurs along the eastern slopes of the Appalachian mountains from New York to North Carolina and is known by various names. In New York state it is called "Esopus stone" and is found in Ulster county, in the Oneida conglomerate. Millstones are now used extensively for grinding the coarser cereals, mineral paint ores, fertilizers, cement rock, barytes, and other minerals. Before the introduction of the roller process in milling, millstones were used principally in grinding wheat.

The 22 operators of the state reported for 1902 a production of 5,158 stones, valued at $39,570. All the quarries from which the rock was taken were in Ulster county. As the value of the buhrstones and millstones made in the United States in 1902 was $59,808, New York state alone furnished 66.2 per cent of this amount.

All other minerals. Deposits of clay occur in nearly every county in the state, but the most important are those of the Hudson valley. This region is probably the most active brickmaking region in the world. In 1902 its operators produced 782,932,000 common brick, or 73.7 per cent of the total output of common brick reported for the state. The production was exceeded by only two states. New York ranked fifth among the states in 1902 in the value of its products of clay, which amounted to $8,414,113. The value of the clay mined and sold by the 7 operators in 1902 was $14,535.[2]

The crystalline quartz mined in Dutchess county in 1902 was used as a wood filler. No statistics can be shown for the single operator of the state without disclosing individual operations. The single productive feldspar mine of the state in 1902 was near Bedford, in Westchester county. The two productive flint mines in the state in 1902 were both in Westchester county. The deposit of infusorial earth of White Lake at Wilmurt, in Herkimer county, is dug from the bottom of the lake, which covers about 4 acres, and has a thickness of from 2 to 30 feet, being covered by about 4 feet of water.[3] As early as 1740 lead ore is said to have been mined in Dutchess county, and in both Columbia and St. Lawrence counties it was mined early in the last century. The presence of both lead and zinc was known in many other localities throughout the state, and much money was expended in the exploitation of this industry.[4] Only one mine, in St. Lawrence county, was productive in 1902. Under the classification "mineral pigments, crude," are the statistics for the production of ores used in the manufacture of mineral paints. Such ores were produced during 1902 in Cattaraugus, Rensselaer, and Washington counties, but the entire output of the 5 mines was only 1,261 tons, valued at $4,251. The single productive pyrite mine in the state in 1902 was located in St. Lawrence county.

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[1] New York State Museum, Nineteenth Report of the State Geologist, 1899, pages r 153 and r 154.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 729, 748, and 769.

[3] New York State Museum, Bulletin No. 15, pages 555 and 556.

[4] Mineralogy of New York, pages 45 to 52.

NORTH CAROLINA.

Table 1 is a summary of the statistics for the productive mines and quarries of the state of North Carolina for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Siliceous crystalline rocks.	Talc and soapstone.	Gold and silver.	Mica.	Monazite.	Barytes.	All other minerals.[1]
Number of mines or quarries	126	30	6	15	28	23	5	19
Number of operators	137	27	6	15	26	22	5	36
Salaried officials, clerks, etc.:								
Number	120	31	12	21	4	3	13	36
Salaries	$84,244	$23,578	$7,710	$18,287	$1,411	$2,100	$5,401	$25,757
Wage-earners:								
Average number	1,556	615	62	203	50	88	34	504
Wages	$517,765	$222,868	$21,416	$66,822	$15,163	$25,318	$9,911	$156,267
Contract work	$9,000						$1,000	$8,000
Miscellaneous expenses	$76,842	$16,463	$27,961	$10,258	$2,962	$2,063	$5,966	$11,289
Cost of supplies and materials	$118,782	$42,884	$12,447	$26,490	$3,121	$256	$2,740	$30,844
Value of products	$927,376	$338,750	$68,962	$71,287	$71,148	$84,160	$44,130	$248,939

[1] Includes operators as follows: Buhrstones and millstones (operator reported under siliceous crystalline rocks); clay, 3; coal, bituminous, 1; copper ore, 2; garnet, 1; graphite, 2; iron ore, 3; limestones and dolomites, 4; precious stones, 18 (1 mine); sandstones and quartzites, 2.

The state ranked forty-second in 1902 in the value of products of mines and quarries, with a total of $927,376. This small product (less than one-eighth of 1 per cent of the total for the United States) should not be taken, however, as a measure of the state's relative importance in quantity and diversity of mineral resources. The minerals contributing to this total and arranged in the order of values were siliceous crystalline rocks, talc and soapstone, clay, gold and silver, mica, monazite, iron ore, barytes, bituminous coal, copper ore, limestones and dolomites, garnet, precious stones, sandstones and quartzites, buhrstones and millstones, and graphite.

It will be noted that the production of gold and silver in 1902 was exceeded in value by that of siliceous crystalline rocks and talc and soapstone, and almost equaled by that of mica and monazite. Also that copper and iron ore occupy relatively minor positions, while no yield of zinc ore was reported. These facts suggest the changing character of the state's mineral product and the somewhat checkered and interesting nature of its mining history.

A number of minerals occurring in the state in commercial quantities were not produced in 1902. Asbestos has been found on Tryon mountain, Polk county, about 1½ miles west of Skyuka. It is of the amphibole variety and occurs in what is apparently a series of pockets, which have been traced across the country for nearly a mile. One pocket that was opened measured nearly 100 feet in width. It is of fair quality, and large masses have been taken out in which the fiber was from 10 to 15 inches long. The chromite mines of Yancey county give indications of containing large deposits, and there is a promising deposit on Dark Ridge creek, in Jackson county. Another property recently developed is on Big Ivy creek, Buncombe county, 16 miles northwest from Asheville. Several veins of the black oxide of manganese of considerable extent have been found. Oil shale exists in great thickness in connection with the coal beds and yields a large percentage of oil.[1] Phosphatic deposits were first systematically examined and studied in 1884 by the state survey. They were found to be of two classes. The first class consists of amorphous nodules, occurring in small quantities in Sampson, Pender, Onslow, Duplin, Columbus, and New Hanover counties. These are of little value commercially. The other class is that of the phosphatic conglomerates found in beds of from 1 to 6 feet thick, and located principally in New Hanover and Pender counties. While the percentage of phosphate of lime in these conglomerates does not average over 10 to 20 per cent, they have been ground by several companies for local consumption.[2] Grains of platinum have been discovered among the sands of gold washings in Rutherford and Burke counties, and also near Burnsville, in Yancey county.[1] Nickel minerals in small quantities are associated with many of the basic manganesium rocks. Genthite and garnierite have been found, but thus far they have not been discovered in sufficient quantity to make them a commercial source of nickel. A deposit of nickel ore averaging 1.5 per cent of the metal is located near Morganton, Burke county. Pyrite, which is one of the most common minerals in the state, is found especially in the counties of Catawba, Gaston, Chatham, Union, and Mecklenburg.[2]

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[1] Handbook of North Carolina, by L. L. Polk, page 129.

[2] Eleventh Census, Report on Mineral Industries, page 690.

Other minerals which have been found are: Epidote, ilmenite, manganese ore, manganiferous iron ore, marble, rutilated quartz, rutile, sperrylite, tungsten, uranium, and vanadium.

In addition to the productive mines and quarries of the state, extensive development work was carried on during 1902 on 29 nonproductive mines and quarries, the total outlay in this line amounting to $200,915. Most of this expenditure was applied to the development of gold and silver deposits, phosphate rock and clay sharing the remainder in the order named.

The relative importance of those manufacturing industries which are closely allied to or based upon the mining industry, using as their raw material the product of the mine or quarry, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$94,919,663
Based upon products of mines or quarries:		
Chemicals and allied products	$1,501,024	
Clay, glass, and stone products	1,162,061	
Iron and steel, and their products	1,611,504	
Metals and metal products, other than iron and steel	243,836	
Miscellaneous industries	1,261,978	
		5,780,403
All other		89,139,260

As shown by Table 2, the total value of the products of the manufacturing industries based primarily on mines and quarries was $5,780,403, or 6.1 per cent of the product of all manufacturing industries in the state in 1900.

During the same year there were employed in all branches of manufacture in the state 70,570 wage-earners, who were paid $13,868,430 in wages. In 1902 there were employed in the mines and quarries of the state 1,556 wage-earners, who received $517,765 in wages. On the basis of these figures it is seen that 97.8 per cent of the wage-earners of the combined industries, receiving 96.4 per cent of the wages, were employed in manufacturing, while 2.2 per cent of the wage-earners, receiving 3.6 per cent of the wages, were employed in mining.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production from 1890 to 1902 for the leading minerals of the state for which comparable figures are available:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR.	Siliceous crystalline rocks.	Gold and silver.[1]	Talc and soapstone.	Monazite.
1890	$146,627	$126,397	(2)	(3)
1891	(2)	101,177	(2)	(3)
1892	150,000	90,196	(2)	(3)
1893	122,707	79,505	(2)	[4] $7,600
1894	108,993	52,927	(2)	[4] 36,193
1895	75,000	54,720	(2)	[4] 137,150
1896	10,017	44,946	(2)	[4] 1,500
1897	59,236	34,988	(3)	[4] 1,980
1898	79,969	84,905	$27,320	[4] 13,542
1899	255,544	34,888	31,900	[4] 20,000
1900	257,962	[5] 35,444	75,308	[4] 48,805
1901	251,288	[5] 67,680	77,824	[4] 59,262
1902[6]	338,750	[5] 101,777	88,962	64,160

[1] Estimates of the Director of the Mint for the refined product, silver at coining value. The values given in Table 1 are the values at the mine.
[2] Not reported separately.
[3] No production.
[4] Includes production from South Carolina.
[5] Silver at commercial value.
[6] Census figures, except for gold and silver.

Siliceous crystalline rocks.—Granite and gneiss are among the commonest rocks of the state, being found in all sections except the coastward region. The principal producing counties where good grades of building granites are found are Gaston, Iredell, Rowan, Surry, and Wilkes.[3]

Talc and soapstone.—Talc is a very common mineral in North Carolina, both in the form of the impure greenish massive or slaty rock (potstone), used for monuments and for chimney and furnace hearths and linings, and in the form of a pure massive white steatite. The product for the year 1902 was reported from Cherokee, Moore, and Swain counties, and constituted 7.8 per cent of the total product of the United States. The most extensive beds of this mineral are found in Cherokee and Macon counties in immediate association with the marble range along the Nantahala, Valley, and Nottely rivers.[4]

Clay.—Many varieties of clay of varying value are found at many points in the state, especially in Guilford, Chatham, Wake, Harnett, Robeson, Lenoir, and Jackson counties.[5] In Jackson county extensive beds of kaolin of high grade have been found, and the total clay product of the state for 1902 came from this county.

Gold and silver.—Gold was the principal product of the mines of this state for nearly three-fourths of a century. It is widely distributed, but its principal field is the eastern slope of the Blue Ridge. Silver, on the whole, is a rare mineral in North Carolina. It has been obtained in considerable quantities at Silver Hill, in

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[1] The Minerals and Mineral Localities of North Carolina, by F. A. Genth and W. C. Kerr, page 12.
[2] Geology of North Carolina, by W. C. Kerr, Vol. I, page 58.
[3] Geology of North Carolina, Vol. I, page 271 ff.
[4] Ibid., page 298.
[5] Ibid., page 296.

Davidson county. Other counties in which silver has been found and in some instances mined with indifferent success are Burke, Caldwell, Wilkes, Gaston, Cabarrus, Union, Montgomery, McDowell, Madison, Johnston, Cherokee, and Surry.[1]

From the earliest days of placer gold mining in 1799 on the tributaries of the Pedee down to the decade immediately preceding the Civil War, North Carolina ranked as a mining state of the first importance. The bulk of the mining done in the state during this period was gold mining, and from 1804 to 1827 all the gold produced in the United States, amounting to $110,000, came from the mines of this state.[2] That part of the product of the gold mines of the state which was deposited in the United States Mint and its branches between 1804 and 1866 amounted to nearly $10,000,000.

After the working out of the principal placer deposits, and when the progress in quartz mining had reached the point where, owing to the fineness of the gold and the increasingly refractory character of the ores as the water level was reached, further profitable prosecution of mining with the crude machinery then in use had become a problem of doubtful solution, a decline took place in mining activity. This decline was greatly accentuated by the discovery in California in 1848 of rich placer deposits and by the beginning in 1851 of quartz mining in the same state, where high-grade, free-milling ores had been found in great abundance. Finally, the advent of the Civil War and the discontinuance of the branches of the United States Mint at Charlotte, N. C., and Dahlonega, Ga., brought to a practical close this long and interesting period of mining activity in the state's history.

Since 1866 mining for gold has been carried on in the state in a somewhat desultory way, and in later years other minerals and other sections of the state have claimed attention. The mineral wealth of the state is by no means confined to the eastern slope of the Blue Ridge—the principal gold belt. West of that range, between Smoky mountains and the Blue Ridge, and from the upper water of the French Broad river westward, there is a rich mining field.

Mica. Mica is found in a half dozen or more counties in the state, most of which lie west of the Blue Ridge. The most noted localities are in Mitchell and Yancey counties on the waters of the Nolichucky between the Black mountain and the Roan. In this basin are a great many enormous ledges of granite from which the marketable mica is obtained.[3]

Modern mica mining in the state dates from 1870, since which time North Carolina has produced a very important percentage of the total yield of this mineral in the United States. In 1870 the entire reported product of the country was from this state. In 1880 it was 48.3 per cent; in 1890, 13.3 per cent; and in 1902, 59.9 per cent of the total.

There is one point of unusual interest connected with the history of mica mining in this state. The industry is not really a new one, but has only been revived. The present workings are continually cutting into ancient shafts and tunnels, and hundreds of spurs and ridges of the mountains, especially all over Mitchell county, are found to be honeycombed with extensive ancient workings of which no one knows the date or history. In one locality open pits 40 to 50 feet wide by 75 to 100 feet long, filled up to 15 or 20 feet of depth, are disposed along the sloping crest of a long terminal ridge or spur of a neighboring mountain. The excavated earth is piled in huge heaps about the margins of the pits and the whole overgrown with the heaviest forest trees—oak and chestnut—some of them 3 feet and more in diameter, and some of the largest, belonging to a former generation of forest growth, fallen and decayed.[1] It would thus appear that not less than three hundred years have passed since these pioneer toilers wrote in the unmistakable language of pits and tunnels the first chapter of the history of mining in the state. These old workings were at one time thought to be abandoned Spanish silver mines. There is no appearance, however, of a silver vein and no explanation of the object of these extensive works other than that they were for the purpose of obtaining the large plates of mica or crystals of cyanite, both of which abound in the coarse granite rock. It is known that mica was of common occurrence in the tumuli of the Mound Builders, among the utensils and ornaments which such primitive people were in the habit of burying with their dead. Many cut forms similar to those found in the mounds have been discovered among the rubbish and refuse heaps about and in these old pits. These facts reveal, therefore, the purpose and probable date of these ancient workings and show them to have been contemporary with the extensive copper mining operations of Lake Superior.[1]

Monazite. The total product of monazite mining in the United States reported in 1902 came from the state of North Carolina. While the existence of monazite in commercial quantities in this state was first established in 1879, by Mr. W. E. Hidden, of New York, who, in the interest of Thomas A. Edison, the inventor, inspected the gold placers on a hunt for platinum, the first recorded product of monazite mining in the state was in 1887, and came from the Brindleton district, in Burke county.[2]

Iron ore. The first recorded discovery of iron ore in North America occurred in the year 1585, in North

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[1] The Minerals and Mineral Localities of North Carolina, page 12, and Geology of North Carolina, Vol. I, page 288 ff.

[2] United States Geological Survey, Sixteenth Annual Report, Part III, page 256.

[3] Geology of North Carolina, Vol. I, page 289.

[1] Geology of North Carolina, Vol. I, page 301.

[2] Minerals and Mineral Localities of North Carolina, pages 89 and 90.

Carolina. It was made by an expedition fitted out by Sir Walter Raleigh, and commanded by Ralph Lane, and which attempted to plant an English colony on Roanoke Island. The ore was found near the coast, and although the importance of the discovery was fully realized, no attempt was made to utilize it, as the colonists were then on a search for gold. It was many years after that a permanent settlement was made, and the industry of iron mining and manufacture was well under way in many other colonies before its beginning here.[1] Iron ores of high grade and in large quantities have been found in many sections of the state, and at different periods during the last hundred and twenty-five years the production of iron in the state was an industry of relatively marked importance. The ranges of iron ore deposits are widely distributed, but in the main fall within the following counties: Chatham, Orange, Guilford, Gaston, Lincoln, Catawba, Yadkin, Surry, Stokes, Mitchell, Ashe, Madison, Cherokee, and Johnston.[2] The product of the state is still small. That reported for 1902 came from Johnston, Madison, and Mitchell counties.

Barytes.—The commercial production of barytes in North Carolina, first noted at the census of 1889, is confined chiefly to Madison county, though deposits have also been found in Gaston, Orange, Cabarrus, and Union counties.[3] For the year 1902 the production of barytes was $44,130, or 21.7 per cent of the total product of the United States.

All other minerals. Deposits of bituminous coal exist in the state in Stokes and Rockingham counties, in the valley of the Deep river. Coal has also been found in Chatham and Moore counties.[4] No statistics can be shown without disclosing individual operations.

Copper ore is found in many places in the state, the principal variety being chalcopyrite, or copper pyrites. Before the Civil War the industry of copper mining had made considerable headway. Many of the gold veins are associated with pyritic ores, practically all the old copper mines of the central part of the state having been worked first for gold. The general character of these mines was that at about water level the so-called "brown gold ores" were replaced by quartz richly charged with iron pyrites more or less mixed with copper pyrites, the latter increasing as the mine deepens, and in many places becoming the only or the predominating ores, and forming a regular copper vein. Perhaps the most valuable deposits of copper in the state are in Ashe, Alleghany, and Watauga counties; the most remarkable vein in this range is at Ore Knob, in the southeast corner of Ashe county, near the top of the Blue Ridge.[5]

Abrasive garnet is widely distributed through the state, and is a regular constituent of many of the mica and hornblende slates. Large crystals of a brownish red color are frequently met with in the mica mines of Mitchell and Yancey counties. The product of the North Carolina garnet mines has obtained the highest price in the market, $60 per ton. The total product of the state for 1902 was from Jackson county.

Graphite occurs in many localities in the state. The largest beds are in Wake county. Others occur in Lincoln, Cleveland, Catawba, Alexander, Stokes, Wilkes, Person, and Yancey counties.[6]

Limestones though not abundant are found in more than twenty counties, and distributed throughout the state. Those in the eastern part are a shell conglomerate, valuable both for building purposes and for the manufacture of lime. Those of the middle and western section are frequently crystalline, and in several counties, especially in Cherokee and Macon, constitute a very good marble.

Precious stones have been picked up at many places in the central and western part of the state. Among these have been a half dozen or more diamonds. The first one was found in 1843 by Dr. M. F. Stephenson, of Gainesville, Ga., at the ford of Brindleton creek, in Burke county, and was worth about $100.[7] Garnet crystals of great beauty and perfection and of various colors are found in Burke, Caldwell, and Catawba counties.[8] A peculiar green garnet has been found in the Cowee valley, for which the name rhodolite has been generally adopted. Many emerald matrix specimens have been found at Crab Tree mountain in Mitchell county. Mining for amethyst has met with considerable success at Tesnaty, on the creek of that name, in Smith Bridge township, Mitchell county, where a large vein occurs in an altered pegmatite. Crystals are found from one-half to 3 inches in length, and in color they are light and dark, the dark spots often being of the deepest, richest purple. No finer amethysts have been found in the United States. Several thousand dollars worth of stones were sold from the first development work. A very interesting new form of moonstone has been found near Bakersville. The well-known occurrence of pink and red ruby corundum in a green amphibole

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[1] Iron in All Ages, by James M. Swank, page 102 ff.

[2] Geology of North Carolina, Vol. I, page 218 ff.

[3] The Minerals and Mineral Localities of North Carolina, page 83.

[4] United States Geological Survey, Sixteenth Annual Report, Part IV, page 153.

[5] Geology of North Carolina, Vol. I, page 271 ff.

[6] Ibid., page 296.

[7] Ibid., page 57 of Appendix

[8] The Minerals and Mineral Localities of North Carolina, page 47 ff.

(smaragdite) at Buck creek, Clay county, has been utilized as a new semiprecious stone. Pieces are selected in which the bright spots of red or pink ruby are inclosed in the bright green matrix. The stone is being introduced under the name of ruby matrix.

Sandstone of a superior quality has long been quarried in the state. It is found in two narrow zones, one lying along the valley of the Dan river, near and almost parallel to the northern boundary of the state, and the other lying in a northeast and southwest direction, nearly across the eastern side of the middle division of the state.[1] In many places it is of such character as to be well adapted to the purposes of millstones. Conglomerates, which are associated with the sandstone, have been made into excellent millstones, occasionally of such quality as to be almost equal to the French buhrstone. The rocks have been quarried for millstones in Anson, Moore, Madison, Person, Montgomery, and Rowan counties.[2] The total product of the state in 1902 was from Rowan county.

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[1] Geology of North Carolina, Vol. I, page 304.

[2] Ibid., page 35.

NORTH DAKOTA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of North Dakota for 1902.

TABLE 1.—*Summary: 1902.*

	All minerals.[1]
Number of mines or quarries	48
Number of operators	48
Salaried officials, clerks, etc.:	
Number	52
Salaries	$43,980
Wage-earners:	
Average number	298
Wages	$196,534
Contract work	$2,795
Miscellaneous expenses	$23,012
Cost of supplies and materials	$88,867
Value of product	$334,967

[1] Includes operators as follows: Cement, 1; and coal, bituminous, 47.

The lignite coal area of this state is of very great extent, equal to at least half the area of Ohio.[1] Although known for some time the coal fields are of only recent development. Some cement of good quality is manufactured.

There is also every reason to believe that large sandstone quarries will in time be developed, since there are a number of suitable locations only awaiting a sufficient demand to justify extensive development. Granite and gneiss are also found throughout the eastern half of the state, except in the Red river valley, but are not quarried in commercial quantities. The clay fields in the state are wholly undeveloped.[2]

The value of the products of the manufacturing industries of North Dakota, based primarily upon minerals mined and quarried as well as the value of all manufactured products of the state as reported at the Twelfth Census are presented in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$9,183,114
Based upon products of mines or quarries:		
Clay, glass, and stone products	$198,224	
Iron and steel and their products	103,511	
Metals and metal products, other than iron and steel	167,864	
Miscellaneous industries	874,560	
		1,344,159
All other		7,838,955

Table 2 shows that the value of products of manufactures of North Dakota in 1900, based primarily upon minerals mined and quarried, was $1,344,159, or 14.6 per cent of the total. The value of the output of the mines and quarries of the state in 1902 was $334,967, or 3.5 per cent of the combined value of products of manufacturing and mining in North Dakota.

The average number of wage-earners engaged in manufactures in North Dakota as reported at the Twelfth Census was 2,398, and the wages paid amounted to $1,222,472. The average number of wage-earners engaged in mining and quarrying in the state in 1902 was 298, and the wages paid were $196,534. The total number of wage-earners, therefore, employed in mining and manufacturing industries was 2,696, and their wages amounted to $1,419,006. On the basis of these figures, those engaged in manufactures constitute 88.9 per cent of the total number of wage-earners, while their wages amount to 86.1 per cent of the total paid. The wage-earners employed in mining industries constitute 11.1 per cent of the total number employed, and they received 13.8 per cent of the wages paid.

Coal.—Lignite coal in North Dakota underlies an area of 28,620 square miles. This area is a part of the so-called Rocky mountain coal field, which also includes the coal areas of Montana, Wyoming, Utah, Colorado, New Mexico, Idaho, and Nevada.[1] The earliest production of coal worthy of statistical notice was produced in 1884.[1] The North Dakota variety does not stand transportation well, and consequently can not compete with bituminous coal, except when the latter is high priced. To be sold at a profit, therefore, North Dakota coal must at present find a comparatively local market.[1]

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[1] Geological Survey of North Dakota, Second Biennial Report, 1902, page 35.

[2] Ibid., pages 28 to 32.

In 1902 the mines of the 47 operators reporting were located in Burleigh, McLean, Morton, Stark, and Ward counties. The total output was 226,511 short tons. Ward county produced 93,786 tons of this amount.

The following figures taken from the reports of the United States Geological Survey show the quantity and value of the coal mined in the state since 1884:

TABLE 3.—*Annual production of coal, bituminous: 1884 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	Value.	YEAR.	Short tons.	Value.
1884	35,000	[1]	1894	42,015	$47,049
1885	25,000	$34,000	1895	38,997	41,646
1886	25,955	41,277	1896	78,050	84,908
1887	21,470	32,205	1897	77,246	83,903
1888	34,000	112,000	1898	83,895	93,591
1889	28,907	41,431	1899	98,809	117,500
1890	30,000	42,000	1900	129,883	158,348
1891	30,000	42,000	1901	166,601	211,151
1892	40,725	59,250	1902	226,511	325,967
1893	49,630	56,250			

[1] Not reported.

Cement.—No data relative to the single cement plant in the state can be shown without disclosing individual operations. However, it may be said that the plant has been erected about five years and has been a successful though not a very large producer. The plant is located at Pembina, on the Tongue river.[2]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 402.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 802.

OHIO.

Table 1 is a summary of statistics for the productive mines, quarries, and wells in the state of Ohio for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous	Petroleum.	Limestones and dolomites.	Natural gas.	Sandstones and quartzites.[1]	Cement.	Grindstones and pulpstones.	All other minerals.[2]
Number of mines, quarries, and wells	44,934	648	42,483	259	1,352	115	7	7	63
Number of operators	11,338	513	10,002	249	417	91	7	7	52
Salaried officials, clerks, etc.:									
Number	2,530	1,314	450	205	241	200	49	22	49
Salaries	$2,551,083	$1,222,965	$629,959	$155,451	$221,857	$218,590	$57,808	$10,792	$31,240
Wage-earners:									
Average number	37,173	25,963	4,017	3,065	699	2,363	375	139	552
Wages	$23,222,680	$16,693,464	$2,915,787	$1,454,328	$441,581	$1,171,674	$327,548	$64,288	$254,010
Contract work	$2,701,557	$46,818	$2,212,923	$7,276	$433,026				$1,514
Miscellaneous expenses	$7,711,035	$1,619,451	$4,806,861	$139,648	$191,223	$437,827	$71,829	$9,962	$44,205
Cost of supplies and materials	$10,125,452	$2,082,788	$5,504,792	$560,462	$1,139,201	$526,521	$231,322	$19,777	$60,589
Value of product	$57,186,922	$26,953,789	$20,757,859	$3,204,998	$2,355,458	$2,078,754	$714,551	$560,412	$561,101

[1] Includes operating expenses for the production of grindstones and pulpstones, valued at $399,726.

[2] Includes operators as follows: Clay, 31; gypsum (operator reported in Michigan); iron ore, 9; oilstones, whetstones, and scythestones, 1; phosphate rock, 1; silica sand, 7; sulphur and pyrite, 3.

The coal fields of Ohio are extensive and have been yielding over 10,000,000 tons annually since 1889. The petroleum and natural-gas output is very large, a number of the most productive wells in the country being found in this state. Some of Ohio's building stones are among the finest in the United States, and find a ready market. Practically the entire output of grindstones and all the pulpstones produced in this country come from this state. To supply its extensive iron and steel industries Ohio depends on other states for the necessary iron ore, as its own deposits are not rich either in quantity or quality. Ohio is one of the leading states in the manufacture of Portland cement, and has long been a producer of natural rock cement. Sandstone abounds and when crushed and screened is used in glassmaking and for other purposes. Large and valuable deposits of clay aid in giving the state its leading position in the clay working industries.

In addition to the minerals referred to in Table 1, strontium ore is found at Put in Bay, Ottawa county, but none has been produced in commercial quantities since 1897.

The operators reporting active mines and wells, but no production, gave employment to 204 wage-earners and paid $122,722 in wages during 1902. The cost of supplies and materials amounted to $27,912, and of contract work to $14,174.

The relative importance of manufacturing industries closely allied to or based upon the mining industry, using as their raw material the product of the mine or quarry, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$832,438,113
Based upon products of mines or quarries,		
Chemicals and allied products	$18,795,286	
Clay, glass, and stone products	29,630,884	
Iron and steel and their products	255,219,520	
Metals and metal products, other than iron and steel	16,451,964	
Miscellaneous industries	27,722,917	
		347,820,571
All other		484,617,542

From the foregoing table it will be seen that the value of the products of manufactures based primarily upon minerals mined and quarried was $347,820,571, or 41.8 per cent of the total. The value of the output of the mines, quarries, and wells of Ohio for 1902 was $57,186,922, or 6.9 per cent of the total value of all manufacturing and mining products for the state.

The Twelfth Census reported the average number of wage-earners engaged in manufactures in Ohio as 345,869 and the wages paid as $153,955,330. The average number of wage-earners engaged in mining in 1902 was 37,173, and the wages paid were $23,222,680. The manufacturing and mining industries combined gave employment to 383,042 wage-earners and paid $177,178,010 in wages. Manufactures employed 90.2 per cent of the wage-earners and paid 87 per cent of the wages, while mining employed 9.8 per cent of the wage-earners and paid 13 per cent of the total wages.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of this state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Petroleum.	Limestones and dolomites.	Natural gas.	Sandstones and quartzites.	Cement.
1890	$10,783,171	$5,644,195	$1,514,204	$4,684,300	$3,046,656	$42,000
1891	12,106,115	5,576,706	1,250,000	3,076,325	3,200,000	82,000
1892	12,722,745	6,233,059	2,025,000	2,136,000	3,500,000	108,300
1893	12,351,139	8,124,342	1,848,063	1,510,000	2,201,932	85,500
1894	9,841,723	9,206,293	1,733,477	1,276,100	1,777,031	144,425
1895	10,618,477	16,399,242	1,568,713	1,255,700	1,449,659	239,221
1896	10,253,461	17,073,138	1,399,412	1,172,400	1,679,265	267,892
1897	9,535,409	11,252,958	1,486,550	1,171,777	1,600,068	256,291
1898	12,027,336	12,205,210	1,673,160	1,488,308	1,194,746	465,276
1899	14,351,903	20,976,304	1,793,604	1,866,271	1,775,642	721,478
1900	19,292,246	24,091,601	1,969,367	2,178,231	2,233,596	687,769
1901	20,928,158	20,583,571	2,066,502	2,147,215	2,576,723	758,837
1902[1]	26,953,789	20,757,359	3,204,998	2,355,158	2,078,751	714,551

[1] Census figures.

Coal.—The coal fields of Ohio underlie between 10,000 and 12,000 square miles of the state area, and are located in some thirty counties in the eastern and southeastern portion of the state. They belong to the northern Appalachian system, which also includes the coal areas contained in western Pennsylvania, Maryland, Virginia, West Virginia, and eastern Kentucky. The coals are all of the bituminous variety and are known in general terms as block, gas, cannel coal, etc., and by special names indicating the producing localities. At what period the deposits first became known is uncertain, but they were known to exist certainly as early as 1770.[1] Although some coal was undoubtedly produced prior to 1828,[2] when the first recorded shipment was made, the first production recorded was in 1838. The history of the output was not kept with any accuracy before 1872.

Of the 29 coal producing counties in Ohio in 1902, 9 had a production of 1,000,000 tons or over, and of the 648 mines 2 had an output of 1,000,000 tons or over, and 51 an output of 100,000 tons or over. The largest coal producing counties were Athens, Belmont, Guernsey, Hocking, Jackson, Jefferson, Perry, Stark, and Tuscarawas. Ohio ranked second in quantity of product among the coal states until 1883, when Illinois outranked it; in 1896 West Virginia ranked third, Ohio taking fourth place. This place it still held in 1902, although in value of coal produced it ranked third.

The following table shows the annual production of coal in Ohio from 1838 to 1902. The figures for many of the years prior to 1872 are estimates.

TABLE 4.—*Annual production of coal, bituminous: 1838 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1838	119,952	1871	4,000,000
1839	125,000	1872	5,315,294
1840	140,536	1873	4,550,028
1841	160,000	1874	3,267,585
1842	225,000	1875	4,864,259
1843	280,000	1876	3,500,000
1844	340,000	1877	5,250,000
1845	390,000	1878	6,500,000
1846	420,000	1879	6,000,000
1847	480,000	1880	7,000,000
1848	540,000	1881	8,225,000
1849	600,000	1882	9,450,000
1850	640,000	1883	8,229,429
1851	670,000	1884	7,640,062
1852	700,000	1885	7,816,179
1853	760,000	1886	8,435,211
1854	800,000	1887	10,300,708
1855	890,000	1888	10,910,951
1856	930,000	1889	9,976,787
1857	975,000	1890	11,494,506
1858	1,000,000	1891	12,868,683
1859	1,060,000	1892	13,562,927
1860	1,133,596	1893	13,253,646
1861	1,150,000	1894	11,909,856
1862	1,200,000	1895	13,355,806
1863	1,204,581	1896	12,875,202
1864	1,815,622	1897	12,196,942
1865	1,536,218	1898	14,516,867
1866	1,887,424	1899	16,500,270
1867	2,092,334	1900	18,988,150
1868	2,475,844	1901	20,943,807
1869	2,161,986	1902	23,519,894
1870	2,830,579		

Petroleum.—As early as 1814 petroleum was obtained in brine wells, but it was not until after Drake's discovery on Oil creek, Pa., in 1859, that the oil region in the southeastern part of Ohio began to attract attention.[3] The Trenton rock, or Lima district, in the northwestern part of the state, did not receive any serious consideration until 1885, when the great Cincinnati arch began to be looked upon as a probable factor in the crude petroleum field.[4] The Trenton rock petroleum comes from a limestone instead of a sandstone formation, is dark in color, and contains a considerable quantity of sulphureted hydrogen, making it rather refractory for refining purposes. The Lima district, extending through Wood, Hancock, Allen, Sandusky, Auglaize, Mercer, Van Wert, Lucas, Wyandot, and Ottawa counties, has been one of the largest producers in the United States, and in 1902 its production was about 75 per cent of the petroleum produced in Ohio.

Since 1895 Ohio has ranked first among the petroleum producing states. In 1902 its 42,483 wells had an output of 21,014,231 barrels, or nearly 24 per cent of the entire production of the United States for that year. While Ohio's petroleum output for 1902 was less than that for 1901, the product sold at an increase in price averaging 4 cents per barrel.

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[1] One Hundred Years of American Commerce, Vol. I, page 178.

[2] United States Geological Survey, Twenty-second Annual Report, Part III, page 216.

[3] Tenth Census, Vol. X, page 12.

[4] United States Geological Survey, "Petroleum Bulletin," 1902, page 90.

The following table shows the annual production of petroleum in Ohio from the beginning of operations until the close of 1902:

TABLE 5.—*Annual production of petroleum: 1876 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
Total	283,751,317	1888	10,010,868
		1889	12,471,466
Previous to 1876	200,000	1890	16,124,656
1876	31,763	1891	17,740,301
1877	29,888	1892	16,362,921
1878	38,179	1893	16,249,769
1879	29,112	1894	16,792,154
1880	38,940	1895	19,545,233
1881	33,867	1896	23,941,169
1882	39,761	1897	21,560,515
1883	47,632	1898	18,738,708
1884	90,081	1899	21,142,108
1885	661,580	1900	22,362,730
1886	1,782,970	1901	21,648,083
1887	5,022,632	1902	21,014,231

Limestones and dolomites. These stones are mentioned in the Second Annual Report of the Geological Survey of Ohio as having been used as early as 1838 for building, burning into lime, macadamizing roads, and even for ornamental purposes. They are almost uniformly of a dull color, and though in many cases durable and strong, are entirely unfit for any sort of fine building or ornamental work. They are, therefore, used chiefly for the rough work of foundations, street paving, and flagging, and to a very large extent for making quicklime.[1]

Ohio in 1902 ranked third in value of product in the list of limestone producing states, being exceeded by Pennsylvania and Illinois.

Natural gas.—There are three natural gas fields in Ohio. The first known field was along the eastern margin of the state, where occur the sands of the Lower Coal Measures, the Waverly Series, and the Ohio shales. The second field, the last to be developed, is in the central portion of the state and receives its natural gas from the Clinton limestone of the Upper Silurian series. The third field is found in the northwestern portion of the state and obtains its natural gas exclusively from the upper portion of the Trenton limestone of the Lower Silurian series. Natural gas was first used in Ohio in 1866 in the manufacture of lampblack at Gambier, Coshocton county; in 1874 it was used at East Liverpool, in the household, for heat and light. The great Trenton rock gas field was first opened at Findlay in November, 1884, and the Lancaster gas field was developed by a well drilled near that city in 1887.[2] The gas produced from the eastern portion of the state was not developed in sufficient quantities to warrant the piping of it to far distant localities, but it has been an important factor in supplying many nearby towns and industries.

The value of the natural gas produced in Ohio in 1902 was $2,355,458, which is an increase of $208,243 over 1901. The greatest production was in 1889, after the great Findlay gas field had been first opened; the smallest production was in 1897, just before the Lancaster and Sugar Grove pools were developed. Of the 1,352 wells in operation during 1902, the 637 wells located in the counties of Fairfield, Franklin, Hancock, Licking, Knox, Belmont, Guernsey, Noble, and Mercer produced natural gas valued at $2,107,731. The remaining 715 wells were located in the following counties: Allen, Ashtabula, Auglaize, Columbiana, Cuyahoga, Darke, Hardin, Harrison, Holmes, Lake, Logan, Lorain, Lucas, Monroe, Morgan, Ottawa, Sandusky, Stark, Van Wert, Washington, and Wood.

Sandstones and quartzites.—Quarries of excellent sandstone abound in Ohio, of which the so-called Waverly group are the most important for building purposes.[3] The greatest sandstone deposits, known geologically as the Berea grit, are located in Cuyahoga and Lorain counties. The stone, of a very light buff, gray, or blue-gray color, is famous for its evenness of color and purity of texture, and for building purposes finds a ready market throughout the United States. The value of the sandstone quarried in these two counties in 1902 for building purposes amounted to $828,284.

The value of the sandstones and quartzites production of Ohio for 1902, $2,078,754, is exceeded only by that of Pennsylvania. These figures do not include the value of stone quarried for grindstones and pulpstones. The 115 quarries operated during 1902 were located in the following counties, arranged according to the value of the production: Cuyahoga, Lorain, Scioto, Fairfield, Summit, Erie, Richland, Morrow, Belmont, Carroll, Huron, Muskingum, Mahoning, Trumbull, Crawford, Holmes, Harrison, Jefferson, Stark, Morgan, Tuscarawas, Washington, Meigs, Pike, Columbiana, Ashtabula, Guernsey, Licking, Delaware, Miami, Pickaway, Highland, and Perry.

Cement.—Among the first cement plants to be established was a small one at Sandusky, about 1845. In 1846 a plant was established at Defiance, and in 1858 at Barnesville. The first Portland cement plant was established in 1889.[4] In 1902 Ohio ranked seventh among the states manufacturing this material. While the growth of this industry in Ohio has been steady, it has not been as marked as in some other states. In 1890 the production amounted to only 57,000 barrels while in 1902 it amounted to 563,113 barrels. But one company now produces natural rock cement.

Grindstones and pulpstones.—Four-fifths of all the grindstones produced in the United States are quarried in Ohio, the sandstone known as the Berea grit being the greatest source of supply. The 7 quarries operating in 1902 were located in Cuyahoga, Stark, Jefferson, Athens, and Washington counties. The value of the total output in Ohio was $560,412, while that of the United States was $667,431.

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[1] Stones for Building and Decoration, by George P. Merrill, page 319.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 645.

[3] Stones for Building and Decoration, page 154.

[4] United States Geological Survey, "Mineral Resources of the United States," 1902, page 803.

The following table shows the value of the annual production of grindstones, 1899 to 1902, it being impossible to segregate the production from the total for the United States previous to 1899:

TABLE 6.—*Value of annual production of grindstones: 1899 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Value.	YEAR.	Value.
1899	$480,965	1901	$548,811
1900	512,721	1902	560,412

All other minerals.—The value of raw clay produced by the 31 operators in 1902 was $101,305.

The single gypsum plant in the state is near Gypsum, in Ottawa county. The product is converted principally into wall plaster.

The first blast furnace in Ohio was completed in 1804, in Mahoning county,[1] and it is probable that iron ore was first mined in this state about that time. The Hanging Rock district, in Lawrence county, along the Ohio river, was once quite a source of supply, but during late years the quantity of iron ore mined in Ohio has steadily decreased, owing probably to the inferiority of the ore. In 1889 the production of iron ore in Ohio amounted to 254,294 long tons, while in 1902 it was only 22,657 long tons.

The silica sand production for 1902 was valued at $152,274. A little less than a quarter of this crushed sandstone is used in the manufacture of glass.

At a number of the quarries in the Berea sandstone district a grade of stone is found suitable for making whetstones. The well-known Deerlick oilstone is made at Chagrin Falls, Cuyahoga county. The value of the production of whetstones and oilstones in Ohio can not be shown separately without disclosing the operations of an individual establishment.

The pyrite produced by three operators in Tuscarawas county is a by-product of coal. The phosphate rock produced is found in Mahoning county.

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[1] Iron in All Ages, by James M. Swank, page 301.

OKLAHOMA.

Table 1 is a summary of the statistics for the productive quarries and wells in the territory of Oklahoma for 1902:

TABLE 1.—*Summary: 1902.*

	Total.	Limestones and dolomites.	All other minerals.[1]
Number of quarries and wells	21	12	9
Number of operators	17	12	5
Salaried officials, clerks, etc.:			
Number	18	4	14
Salaries	$12,223	$3,035	$9,188
Wage-earners:			
Average number	128	46	82
Wages	$64,535	$22,277	$42,258
Miscellaneous expenses	$15,830	$840	$14,990
Cost of supplies and materials	$31,934	$6,737	$25,197
Value of product	$186,706	$50,541	$136,165

[1] Includes operators as follows: Gypsum, 3 (5 quarries); petroleum, 1 (3 wells); sandstones and quartzites, 1.

From the above table it appears that mining in Oklahoma during 1902 was confined to the quarrying of limestone, gypsum, sandstone, and the operation of three petroleum wells. Gypsum is by far the most important product of mineral industry in the territory.

Many stories have been circulated from time to time regarding old Spanish mines existing in Oklahoma,[1] but they have little foundation. It is claimed, however, that dates cut in the rocks in the Wichita mountains[2] indicate the discovery of gold as early as 1832. These mountains are located in the forbidden ground of the Kiowa and Comanche reservation in the southwestern part of the territory, and prospectors or miners are not allowed to explore the locality.

There are indications in many parts of the territory of the occurrence of coal, asphalt, zinc, lead, copper, iron, cobalt, mica, clay, and cement,[3] but no production of these minerals was reported in 1902. Coal has been obtained in small quantities in Pawnee county and in the Osage reservation, and is also known to occur in Payne, Lincoln, Logan, and Pottawatomie counties and in the Kiowa and Comanche reservation.

Deposits of copper occur near Kenton in the extreme western end of Beaver county; zinc and lead are found in several places in eastern Oklahoma and in the Kiowa and Comanche reservation; and asphalt is known to occur in Comanche and Kiowa counties, in some places even oozing from the ground. Natural gas in small quantities is found in Kay and Greer counties, but no profitable flow has been obtained.[1]

An excellent quality of dolomitic limestone is found in Blaine county and deposits of granitic rocks occur in the Wichita mountains. Cement is found in a number of localities, and beds of clay suitable for the manufacture of building and paving brick occur in various parts of the territory. Cobalt and iron ore are among the minerals reported by Lewis and Clarke in their exploration into this territory in 1803 to 1807.

The value of the products of those manufacturing industries based primarily on the products of mines and quarries is shown in Table 2 in comparison with the total value of products of all manufactures.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$7,083,938
Based upon products of mines or quarries		
Clay, glass, and stone products	$252,072	
Iron and steel and their products	59,250	
Metals and metal products, other than iron and steel	123,418	
Miscellaneous industries	188,881	
		623,621
All other		6,460,317

As shown in the above table the manufactures of Oklahoma, based on the products of mines and quarries, represent but 8.8 per cent of the total of all manufactures. The mineral industry is insignificant when compared with manufacturing in the territory; the value of the product of mines, quarries, and wells in 1902 being only 2.6 per cent of the total obtained by combining the total value of manufactured products in 1900 with the total value of the products of mines, quarries, and wells in 1902.

At the Twelfth Census manufactures were reported as giving employment to 2,054 wage-earners who were paid $807,826 in wages. Mines and quarries in 1902 employed 128 wage-earners and paid $64,545 in wages. Manufactures therefore contributed 94.1 per cent of the wage-earners of the two industries and paid 92.6 per cent of the wages, while mines and mining gave employment to 5.9 per cent of the wage-earners and paid 7.4 per cent of the wages.

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[1] Report of the Governor of Oklahoma, 1899, page 79.

[2] Ibid., 1903, page 69.

[3] Ibid., 1899, pages 78 and 79.

[1] Report of the Governor of Oklahoma, 1901, page 102.

Limestones and dolomites.—Quarrying operations for limestones and dolomites are extensively carried on in Kay county, which locality reports the only commercial production in 1902. The value of the output from the 12 productive quarries was $50,541. The stone was used principally for building, flagging, and curbing.

During 1901 the product of the limestone quarries was chiefly crushed stone used for railroad ballast, building purposes, etc., and was valued at $32,497.[1]

All other minerals.—One of the most promising natural products of Oklahoma is gypsum, for which a considerable development is reported during the past few years, due principally to the extension of railroads through the territory.[2] In 1852, in his account of this locality, Marcy made the statement that the discovery of gold in the Wichita mountains would attract more attention, but that the gypsum beds would be worth more than the gold.

Extending across the territory are great ledges of gypsum. In some places along the rivers and creeks, this soluble rock has succumbed to the action of the water, and caves, tunnels, natural bridges, and fantastic figures have been produced. Only the most convenient and advantageous outcrops have thus far been quarried.[3]

The following table, compiled from reports of the United States Geological Survey, shows the annual production of gypsum from 1898 to 1902:

TABLE 3.—*Annual production of gypsum: 1898 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (short tons).	Value.
1898	3,150	$12,000
1899	11,526	36,600
1900	18,437	60,389
1901	16,930	66,031
1902	34,156	111,215

In 1902 the territory's production of gypsum was quarried in the counties of Blaine, Caddo, Canadian, and Kay. The product is reported to be of the same character as that obtained in Kansas,[4] and it was all calcined as wall plaster or plaster of Paris. The first commercial production was reported in 1894, and amounted to 1,300 short tons valued at $7,500. No operations were reported during the next three years, but in 1898, 3,150 short tons were produced valued at $12,000, and since then there has been a steady increase.

Sandstone occurs as a surface rock in almost every county in Oklahoma, varying in texture from a coarse, rotten shale to a hard, fine grained stone.[5] The production in the territory for 1902 was all quarried in Logan county. It was used chiefly in the rough for foundations and similar building purposes, and also in small quantities as crushed stone for roadmaking.

There were three producing petroleum wells in the territory in 1902, all in Greer county. Two of them were drilled during the year. The petroleum is a heavy black lubricating oil, and it is found in hard, porous rock. Indications of large oil deposits occur in various parts of the territory,[5] notably in the Osage reservation and in Payne, Lincoln, Pottawatomie, Oklahoma, Comanche, and Kiowa counties.

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[1] United States Geological Survey, "Mineral, Resources of the United States," 1902, page 697.

[2] Ibid., page 906.

[3] Report of the Governor of Oklahoma, 1900, page 79.

[4] The Mineral Industry, 1897, Vol. VI, page 392.

[5] Report of the Governor of Oklahoma, 1901, page 102.

OREGON.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Oregon for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Gold and silver	Coal, bituminous.	Siliceous crystalline rocks.	Limestones and dolomites.	All other minerals[1]
Number of mines or quarries	294	262	9	10	7	6
Number of operators	293	262	9	10	6	6
Salaried officials, clerks, etc.						
Number	153	110	32	3	1	7
Salaries	$189,103	$146,473	$27,660	$2,590	$1,200	$11,180
Wage-earners.						
Average number	1,166	855	211	35	19	46
Wages	$1,083,075	$816,711	$144,801	$25,454	$10,102	$86,007
Contract work	$19,622	$18,797				$825
Miscellaneous expenses	$143,748	$114,402	$25,737	$977	$120	$2,512
Cost of supplies and materials	$408,112	$299,705	$86,355	$1,496	$4,220	$16,336
Value of product	$2,067,389	$1,811,853	$160,075	$58,429	$20,133	$16,899

[1] Includes operators as follows: Borax, 1; copper, 2; gypsum, 1; nickel and cobalt, 1; sandstones and quartzites, 1.

In the Blue mountain region and the Rogue river section of the state are the principal gold producing localities. Although silver bearing ore is quite widely diffused, the production reported was principally obtained in the form of alloy with gold. The presence of more or less important coal deposits is indicated by outcroppings throughout the western and northwestern parts of the state and in Coos county. The deposits of stone promise unlimited supplies of building material.[1] Gypsum, used in making land plaster, occurs in Baker county; borax is found in Harney county; deposits of copper are known to exist in many portions of the state; and nickel ore occurs in Douglas county.

In addition to the production reported, valuable mineral deposits occur in many portions of the state. Some of these regions have been prospected or operated to a considerable extent, while others await only the advent of transportation facilities or the expenditure of sufficient capital in development to make them valuable workings. A synopsis of the principal of these known occurrences is herewith given, compiled chiefly from the facts given in the third revised edition of "The Resources of the State of Oregon," as collected and prepared by the state board of agriculture.

Antimony occurs in Jackson county, and asbestos of good fiber is found in the southern and eastern part of the state. Alkaline salts, potash, sodium, and niter, and also borax, for which a production is reported in 1902, are obtainable from lakes and springs in the arid region, east of the Cascades. Natural cement is reported in Douglas county and chrome iron ore or chromite in a condition of remarkable purity and in almost exhaustless quantity is being developed in the serpentine formations of Coos, Curry, Douglas, and Josephine counties. Clay is found in Clackamas, Clatsop, and Coos counties; glass sand exists in streams flowing from granite rocks; and graphite and infusorial earth are obtained in Jackson county.

Important deposits of iron ores exist, chiefly in basalt, in twelve counties, for the most part in the western half of the state, although occurrences are also noted in Umatilla and Grant counties in the Blue mountains. Lead is found in Clackamas, Grant, and Linn counties, principally as galena. Magnesite and other refractory minerals are obtainable, at least in small quantities, in the serpentine rocks of southern Oregon. Manganese ore occurs in Columbia county, in the northern part of the state; marble is found in Josephine and Wallowa counties, and platinum and iridium in lodes are believed to exist in the south, principally in Coos, Curry, and Douglas counties. Of the precious stones, jet has been found in Clatsop county, while opals, serpentine, and chrysoprase, generally useful for ornamental purposes and occasionally rising to the dignity of gems, have all been reported in the state. Quicksilver has been noted in Douglas and Jackson counties, and zinc is known to exist in the Cascade range in Lane and Linn counties, chiefly in the form of zinc blende.

Nonproductive development operations were carried on quite extensively in 1902, 192 operators reporting expenditures as follows: Salaries, $162,184; wages, $805,855; contract work, $75,594; cost of supplies and materials, $241,161; and miscellaneous expenses, $47,191. These operations are reported for gold and silver, quicksilver, and coal (bituminous), named in the order of the amount expended.

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[1] The Resources of Oregon, pages 29 to 42.

The relative importance among manufactures of manufacturing industries closely allied to or based upon the mining industry, using as their raw material the product of mine or quarry, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$46,000,587
Based upon products of mines or quarries:		
Chemicals and allied products	$148,559	
Clay, glass, and stone products	321,687	
Iron and steel and their products	1,116,654	
Metals and metal products, other than iron and steel	883,657	
Miscellaneous industries	2,758,294	
		5,441,861
All other		40,558,726

As presented in the above table, the manufactures intimately related to mining and quarrying were valued at $5,441,861, which amount is about two and one-half times the total products of the mineral industry in the state and 11.8 per cent of the total of all manufactures. The product of mining and quarrying in 1902 was $2,087,389, or 4.3 per cent of the combined value of the product of manufactures in 1900 and of mines and quarries in 1902. Manufactures in 1900 gave employment to 17,236 wage-earners, who received $8,333,533 in wages. Mines and quarries in 1902 gave employment to 1,166 wage-earners and paid $1,033,075 in wages. Of the combined figures for the two industries—18,402 wage-earners and $9,366,608 paid in wages—manufactures gave employment to 93.7 per cent of the wage-earners and paid 89 per cent of the wages, while mines and quarries employed but 6.3 per cent of the wage-earners and paid 11 per cent of the wages.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals reported for the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Coal, bituminous.	Silver.[1]	Siliceous crystalline rocks.	Limestones and dolomites.
1890	$1,100,000	$177,875	$96,969	$44,150	(2)
1891	1,640,000	155,478	297,374	3,000	(2)
1892	1,400,000	148,646	70,077	6,000	(2)
1893	1,645,300	164,500	15,257	11,255	$15,100
1894	2,113,356	163,914	10,351	4,998	(2)
1895	888,300	247,901	65,800	1,728	970
1896	1,251,000	294,564	78,998	2,449	1,600
1897	1,353,100	313,890	89,212	1,125	(2)
1898	1,177,600	212,184	168,081	(2)	7,490
1899	1,429,500	260,917	173,641	8,012	8,000
1900	1,694,700	220,001	[3]71,548	5,313	10,900
1901	1,818,100	173,646	[3]96,060	10,764	24,520
1902[4]	1,816,700	160,075	[3]49,119	39,429	20,133

[1] Estimates of the Director of the Mint, value of the refined product; silver at coining value. The values given in Table 1 are the values at the mine.

[2] Not reported separately.

[3] Commercial value.

[4] Census figures, except for gold and silver.

Table 3 shows that there was a slight decrease in mineral production during the past several years, siliceous crystalline rocks being the only industry reporting an increase over 1901. The gold production during 1902 was only slightly less than during the previous year and was considerably greater than that reported at the beginning of the decade.

Gold and silver.—Gold was discovered on the Coquille river in 1852 and along other streams in southern and eastern Oregon.[1] The Blue mountain region is the principal gold producing place, with the Rogue river section second in importance. Placer mining is more productive in the western, and quartz in the eastern part of the state. The first quartz mining was reported in 1860.

Silver bearing ore is quite widely diffused, but the percentage of the precious metal is often disappointing. The silver reported is principally obtained in the form of alloy with gold, but important discoveries in lodes have been prospected and promise well.

The annual production of gold and silver from 1891 to 1902 is given in the following table:

TABLE 4.—*Annual production of gold and silver: 1891 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	Gold (fine ounces).[1]	Silver (fine ounces).[1]	YEAR.	Gold (fine ounces).[1]	Silver (fine ounces).[1]
1891	79,335	230,000	1897	65,456	69,000
1892	67,725	54,200	1898	56,966	130,000
1893	79,592	11,800	1899	69,152	134,300
1894	102,231	8,008	1900	81,980	115,400
1895	42,972	51,000	1901	87,950	160,100
1896	60,517	61,100	1902	87,881	93,300

[1] Estimates of the Director of the Mint are for the refined product.

Coal, bituminous.—The coal production is obtained principally from Coos county, where it has been mined since the early fifties.[1] Outcroppings indicate the existence of deposits throughout the western and northwestern parts of the state as well as in the Blue mountain region. The coal produced is mainly lignite, with an average of less than 50 per cent fixed carbon, a considerable proportion of water, and from 5 to 20 per cent of ash. Oregon coal is free burning and well adapted for steam and heating purposes, although it will not coke. The following table shows the annual production from 1885 to 1902:

TABLE 5.—*Annual production of coal, bituminous: 1885 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1885	50,000	1891	51,826	1897	107,289
1886	45,000	1892	34,6[illegible]	1898	58,184
1887	37,696	1893	41,[illegible]	1899	86,888
1888	75,000	1894	47,521	1900	58,864
1889	64,359	1895	73,685	1901	69,011
1890	61,514	1896	101,721	1902	65,648

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[1] The Resources of Oregon, pages 29 to 42.

The annual product has varied considerably, the year of least production being 1892. The greatest production was reported in 1897; since that time a decreased product has been shown. In 1902 development operations were reported which indicated an increasing interest.

Siliceous crystalline rocks.—Rocks of volcanic origin predominate in the state; among them are the andesites, the true basalts, the trachytes, and the tufas or fragmentary rocks. In 1902 the entire production was reported from Baker, Benton, Gilliam, Jackson, Marion, Multnomah, and Union counties. It was valued at $38,429.

The production during 1902 showed a decided increase as compared with the years following 1890. This increase in 1902 is chiefly attributed to the more extensive use of the stone as a paving material and in roadmaking.

Limestones and dolomites.—Limestone deposits at present commercially worked occur in Baker and Wallowa counties in the northeastern, and Jackson and Josephine counties in the southwestern part of the state. In Grant and Union counties there are valuable deposits,[1] the latter county being covered to a large extent with blue limestone. During 1902 the entire production, valued at $20,133, was used in lime burning; in 1901 a value of $12,420 was reported for lime burning; in 1900, $10,525; and in 1899, $8,000. There was thus a steady increase in the use of limestone for this purpose. The comparatively large product shown for 1901 included a value of $12,100 quarried for paving and roadmaking, while during 1902 siliceous crystalline rocks were more extensively used as a paving material and no limestone was reported except for lime burning.

All other minerals.—The entire production of borax in 1902 was reported by one company in Harney county, although borax and various other alkaline soluble salts are found also in Klamath and Lake counties. The arid plains of this region are of late volcanic origin and contain lakes with no outlets, carrying useful salts in heavy solution. All the production reported was submitted to a process of crystallization before being marketed.

The copper produced is chiefly copper-glance and native copper, carrying gold, and it occurs chiefly in fissure veins. Deposits are known to exist in many parts of the state, notably the native ore and chalcopyrite of the Santiam region in Linn county, the sulphides of the eastern Oregon gold quartz mines, and the native copper of Union and Baker counties.[2] The 1902 production was reported by one company in Josephine county in southern Oregon, and was all reduced by smelting.

A considerable production of gypsum was reported in Baker county, none of which was sold in crude state, all being prepared as land plaster, wall or cement plaster, or plaster of Paris. As only one company was engaged in this production the statistics can not be given separately, because to do so would disclose the operations of an individual establishment.

Nickel ore occurs, in association with garnierite, chromite, magnetite, chrysoprase, chalcedonic quartz, and serpentine minerals, principally in Douglas county.[2] A small production was reported for 1902.

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[1] The Resources of Oregon, pages 29 to 42.

[2] The Resources of Oregon, pages 24 to 42.

PENNSYLVANIA.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Pennsylvania for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Coal, anthracite.	Petroleum.	Natural gas.	Cement.	Limestones and dolomites.	Slate.	Sandstones and quartzites.
Number of mines, quarries, and wells	48,672	1,023	354	40,441	5,408	17	907	91	283
Number of operators	12,266	514	119	9,808	363	11	896	84	258
Salaried officials, clerks, etc.:									
Number	9,388	3,830	3,014	550	718	267	287	259	232
Salaries	$9,592,910	$4,142,197	$2,807,263	$686,098	$769,042	$250,252	$228,856	$190,555	$177,786
Wage-earners:									
Average number	190,905	92,005	69,691	5,610	2,115	5,376	6,934	3,426	2,864
Wages	$111,122,137	$59,848,902	$38,716,113	$4,072,287	$1,309,205	$2,411,652	$2,881,205	$1,879,175	$1,779,993
Contract work	$5,598,071	$474,679	$406,421	$2,909,046	$1,745,500				
Miscellaneous expenses	$23,218,856	$6,178,975	$9,807,239	$3,275,131	$2,899,083	$711,782	$204,428	$312,186	$108,608
Cost of supplies and materials	$53,111,903	$8,224,475	$12,740,780	$3,556,606	$2,687,228	$1,048,508	$972,045	$417,778	$208,880
Value of product	$236,871,417	$106,032,460	$76,173,586	$15,266,023	$14,352,183	$10,223,267	$5,458,133	$3,547,322	$2,800,108

	Iron ore.	Siliceous crystalline rocks.	Clay.	Mineral pigments, crude.	Silica sand.	Marble.	Feldspar.	Flint.	Buhrstones and millstones.	All other minerals.[1]
Number of mines, quarries, and wells	47	44	19	12	14	3	12	4	3	7
Number of operators	42	43	19	12	11	3	12	3	3	62
Salaried officials, clerks, etc.:										
Number	91	58	22	16	15	8	9	1		7
Salaries	$74,788	$60,877	$28,173	$11,002	$11,890	$7,465	$8,712	$1,500		$5,854
Wage-earners:										
Average number	1,140	703	312	148	141	169	125	27	1	58
Wages	$439,207	$341,720	$130,753	$67,006	$64,015	$95,623	$50,876	$11,713	$616	$26,296
Contract work	$1,228		$300							$900
Miscellaneous expenses	$63,376	$41,066	$13,825	$21,270	$8,255	$4,274	$9,074	$3,137	$121	$2,497
Cost of supplies and materials	$166,422	$128,968	$42,349	$22,816	$16,572	$28,430	$32,423	$4,425	$65	$12,575
Value of product	$1,225,153	$661,062	$288,811	$246,346	$205,675	$160,423	$115,660	$42,721	$1,568	$69,797

[1] Includes operators as follows: Crystalline quartz, 1; garnet, 1; graphite, 2; phosphate rock, 1; precious stones, 55 (no mines); talc and soapstone, 2.

The vast and varied mineral resources of Pennsylvania give the state first rank in the mineral industry of the country. The value of the output of the productive mineral properties of the state in 1902 was $236,871,417, or 29.7 per cent of the total value for the United States.

The most important of the state's mineral resources, from a commercial standpoint at least, are its coals. In its vast stores of anthracite coal, which underlie some 484 square miles,[1] Pennsylvania has a notable advantage over other states. There are three groups of parallel valleys in which these coal measures appear, the Northern, or Wyoming and Lackawanna valley, the Middle, or Lehigh and Mahanoy, and the Southern, from which the Lykens valley coal comes.[2] The bituminous coal fields which run in six parallel valleys[3] from New York to Ohio and West Virginia, underlie some 15,800 square miles of the state, and belong to the great Appalachian field, which also includes the coal regions of Ohio, Maryland, Virginia, West Virginia, eastern Kentucky, Tennessee, Georgia, and Alabama.[4]

The petroleum and natural-gas fields cover many square miles of the state's area, and in the combined values of petroleum and natural-gas production Pennsylvania leads among the states.

The Cornwall hills, in Lebanon county, are composed of and underlaid with magnetic iron ore forming one of the most wonderful deposits of this variety of ore in the world. Since 1740 nearly 9,000,000 tons of ore have been quarried from these beds. Fine brown hematite is taken from great open quarry mines in the central valleys and transported by rail to the iron works in the bituminous coal region beyond the Alleghenies and along the Lehigh and Schuylkill valleys.[5]

At Friedensville, in Lehigh county, are located the zinc mines which were opened in 1853, and were strong producers up to 1876.[6] On the Juniata, beds of hard, white, siliceous sandstone occur, large quantities of which are yearly used in glassmaking. The quarries at Slatington, in Lehigh county, produce vast quantities of the finest blue-black slate for billiard tables and mantels, blackboards and slates, flooring and roofing.[1]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 291.

[2] The Anthracite Coal Industry, by Peter Roberts, pages 5 and 6.

[3] King's Handbook of the United States, page 722.

[4] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Part III, pages 125 and 233.

[5] King's Handbook of the United States, pages 721 and 722.

[6] Ore Deposits of the United States, by James F. Kemp, page 175.

The Gap mine, in Lancaster county, once the most important nickel mine in the country, was opened in 1718 and worked for copper until 1852, when the presence of nickel was discovered.[2] The mine is now shut down.

Marble of many varieties, from black to white, is found in the Great Valley, in Chester county, and has been quarried in immense quantities in Montgomery county. Serpentine, or greenstone, largely used in fine buildings, is quarried at Birmingham, and elsewhere in Chester and Delaware counties.[3]

Among other minerals in deposits of which the state is rich may be mentioned the following: The mineral paint, of Parryville; steatite or talc, of Schuylkill; fire clay and flagstones in several localities; the bluestone, of Tunkhannock and Meshoppen; chrome ore and graphite, of Chester county; silver bearing lead, formerly mined in large quantities in Chester county; sandstones, of Swatara and Schuylkill counties; whetstones, of Darby creek; granites, of Delaware and Philadelphia counties; and the kaolin, of Pennsburg and New Garden, used for making porcelain and china.[3]

The minerals found in the state, but which were not produced in commercial quantities in 1902, are chromite, gypsum, ilmenite, lead ore, manganese ore, nickel, platinum, rutile, strontium ore, and zinc.

In addition to the productive mines, quarries, and wells referred to in Table 1, there were 13 operators in 1902 who reported development work, mostly in connection with bituminous coal, natural gas, and slate properties. These operators paid their salaried officials, clerks, etc., $3,590 during the year, gave employment to an average of 44 wage-earners, and paid $20,752 in wages. The work done by contract amounted to $36,332, the miscellaneous expenses were $4,677, and the cost of supplies and materials was $39,216.

The following table shows the value of the output of manufactures, based primarily upon the products of mines and quarries, and also the value of all manufactured products of the state, as reported at the census of 1900:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$1,834,790,860
Based upon products of mines or quarries		
Chemicals and allied products	$60,794,680	
Clay, glass, and stone products	57,386,153	
Iron and steel and their products	632,501,781	
Metals and metal products other than iron and steel	35,504,249	
Miscellaneous industries	86,408,772	
		872,595,635
All other		962,195,225

As will be seen from the foregoing table, the value of the manufactures based primarily upon the products of mines and quarries was $872,595,635, or 47.6 per cent of that for all manufactured products of the state in 1900. The value of the output of the productive mines, quarries, and wells of the state for 1902 was $236,871,417, or 11.4 per cent of the combined value of manufactured products in 1900, and mine and quarry products in 1902.

The manufacturing industries of Pennsylvania, as reported at the Twelfth Census, employed 733,834 wage-earners during 1900 and paid $332,072,670 in wages. In 1902 the operators of the productive mining properties employed 190,935 wage-earners and paid $114,122,437 in wages. The two industries therefore employed a total of 924,769 wage-earners and paid $446,195,107 in wages. Manufactures employed 79.4 per cent of the wage-earners and paid 74.4 per cent of the wages, while mines and quarries employed 20.6 per cent of the wage-earners and paid 25.6 per cent of the wages.

The following table compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of Pennsylvania from 1890 to 1902:

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[1] King's Handbook of the United States, pages 725 and 726.

[2] The Mineral Industry, 1892, Vol. I, page 345.

[3] King's Handbook of the United States, page 726.

TABLE 3.—VALUE OF ANNUAL PRODUCTION OF PRINCIPAL MINERALS: 1890 to 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Coal, anthracite.	Petroleum.	Natural gas.	Cement.	Limestones and dolomites.	Slate.	Sandstones and quartzites.	Iron ore.	Siliceous crystalline rocks.
1890	$35,376,916	$66,383,772	(1)	$9,551,025	$873,950	$2,655,477	$2,011,726	$1,600,150	(1)	$928,252
1891	37,271,053	73,944,735	$21,240,735	7,834,016	1,082,450	2,100,000	2,142,905	750,000	(1)	575,000
1892	39,017,164	82,442,000	15,302,968	7,376,281	1,099,611	1,900,000	2,343,000	650,000	$2,197,028	550,000
1893	38,259,674	85,687,078	12,563,993	6,488,000	928,347	1,582,336	1,472,275	622,552	1,374,313	206,193
1894	29,479,820	78,488,063	15,312,966	6,279,000	987,710	2,026,562	1,620,158	349,787	643,459	600,000
1895	35,980,357	82,019,272	24,900,630	5,852,000	1,056,861	3,055,913	1,647,751	500,000	997,719	500,000
1896	35,368,249	81,748,651	22,982,402	5,528,610	1,528,294	2,104,774	1,726,318	446,926	920,916	159,317
1897	37,686,347	79,301,954	14,295,825	6,242,543	2,757,086	2,327,870	2,365,299	380,813	851,079	349,917
1898	43,352,598	75,414,537	13,608,002	6,806,742	3,392,689	2,746,256	2,491,756	478,451	877,385	237,780
1899	56,247,791	88,142,130	17,053,410	8,337,210	4,546,322	3,098,683	2,537,022	717,053	1,991,772	885,101
1900	77,438,545	85,757,851	18,068,016	10,215,412	5,328,330	3,900,318	2,718,508	1,050,248	1,890,100	396,271
1901	81,397,586	112,504,020	15,439,609	12,688,161	6,750,304	5,081,387	2,984,263	2,063,082	1,561,620	498,008
1902[2]	106,032,460	76,173,586	15,256,093	14,352,183	10,223,267	5,458,493	3,547,322	2,900,108	1,225,453	661,062

[1] Value not reported.

[2] Census figures.

Coal, bituminous.—The bituminous coal fields underlying an area of 15,800 square miles,[1] lie chiefly in the western part of the state, and spread from Ohio, West Virginia, and Maryland northeast toward New York.[2]

The Upper Carboniferous in the bituminous coal fields of Pennsylvania has been divided into the following five subdivisions in descending order: Dunkard, Monongahela, Conemaugh, Allegheny, and Pottsville. The principal sources of coal are the Allegheny and Monongahela formations, over 95 per cent of the output having been derived therefrom. Shipping mines are also located in the Pottsville and Conemaugh formations, the mines of the former being situated on the very extensive outcrop near the margins of the coal fields, while those of the latter are almost entirely confined to the area of this formation near the southern boundary of the state.[3]

The earliest recorded instance of the mining of bituminous coal in Pennsylvania was in 1760, when a coal mine was opened in the deposit along the Monongahela river, at a point opposite the site of the present city of Pittsburg. With the advent of the first steam engine in Pittsburg in 1794 the demand for this fuel increased, and by 1800 a number of mines were being worked on both sides of the river, the coal being used quite extensively in salt works, glass factories, and for general purposes.[3]

Coal was first shipped from Pittsburg in 1803, and in 1846 the shipments from this point down the Ohio river amounted to 214,000 tons. About 1842 commercial shipments from the Blossburg basin began, and a little later the Barclay basin was developed. During the same decade the use of the Sharon block coal in the Mercer county furnaces is said to have begun. The rapid development of the Cambria county coals practically began with the construction of the State Portage and Pennsylvania railroads, and shortly after the completion of the Low Grade division of the Allegheny Valley Railway in 1872 the notable development of the Reynoldsville basin began.[4]

In 1902 there were 1,023 productive bituminous coal mines in Pennsylvania, and the total output was 98,574,367 short tons, or 37.9 per cent of the production of bituminous coal in the United States. The value of this bituminous coal product was $106,032,460, or 44.8 per cent of the total value of all mineral products of the state and 13.3 per cent of the total for the United States in 1902.

Twenty-four counties in the state contributed to the production of this mineral. Among these, Fayette and Westmoreland, which contain the Connellsville coking region and which have stood for a number of years at the head of the bituminous coal producing counties, retained their supremacy, the former having a production of 18,988,058 tons, and the latter 18,811,511 tons. Allegheny county is third in rank, with 11,919,569 tons, and Cambria county, with 10,561,835 tons, ranked fourth.[5]

The following table, compiled from reports of the United States Geological Survey, shows the annual production of bituminous coal in Pennsylvania from 1840 to 1902:

TABLE 4.—*Annual production of coal, bituminous: 1840 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
Total	1,250,945,473	1871	9,040,565
		1872	11,695,040
1840	464,826	1873	13,098,829
1841	475,000	1874	12,320,000
1842	500,000	1875	11,760,000
1843	650,000	1876	12,880,000
1844	675,000	1877	14,000,000
1845	700,000	1878	15,120,000
1846	760,000	1879	16,240,[illegible]
1847	399,840	1880	21,280,000
1848	500,000	1881	22,400,000
1849	750,000	1882	24,640,[illegible]
1850	1,000,000	1883	26,880,000
1851	1,200,000	1884	28,000,000
1852	1,400,000	1885	26,000,000
1853	1,500,000	1886	27,094,501
1854	1,650,000	1887	31,516,856
1855	1,780,000	1888	33,796,727
1856	1,850,000	1889	36,174,089
1857	2,000,000	1890	42,302,173
1858	2,200,000	1891	42,788,490
1859	2,400,000	1892	46,694,576
1860	2,679,773	1893	44,070,724
1861	3,200,000	1894	39,912,463
1862	4,000,000	1895	50,217,228
1863	5,000,000	1896	49,557,453
1864	5,839,000	1897	54,417,974
1865	6,350,000	1898	65,165,133
1866	6,900,000	1899	74,150,175
1867	7,300,000	1900	79,842,326
1868	7,800,000	1901	82,305,946
1869	6,750,000	1902	98,574,367
1870	8,736,399		

Coal, anthracite.—The anthracite coal region of Pennsylvania, situated in the eastern part of the state, embraces a territory of about 3,300 square miles, but only about 484 square miles is underlaid by workable coal measures. These measures are principally located in Lackawanna, Luzerne, Carbon, Schuylkill, and Northumberland counties, but are also found in Susquehanna, Sullivan, Columbia, Dauphin, Wayne, Wyoming, and Lebanon counties,[6] the last three mentioned, however, reporting no production in 1902.

The area is divided geographically into four divisions, known as the Northern, Eastern Middle, Western Middle, and Southern, and there is also a small basin in Sullivan county, known as the Western Northern or Loyalsock.[7] Of these fields, the Northern, also called the Wyoming, contains 200 square miles, or 34 per cent of all the workable coal area. This rich deposit, crescent in form, is 50 miles long and varies in width from

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 293.

[2] Ibid., Twenty-second Annual Report, 1900–1901, Part III, page 127.

[3] Ibid., pages 129 and 188.

[4] Ibid., page 188.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 423.

[6] Ibid., Twenty-second Annual Report, 1900–1901, Part III, page 61.

[7] Ibid., page 63.

5.5 miles to diminishing points where the coal seams end. The extreme northern point of the crescent is in Susquehanna county, near Forest City, and the remainder of the region is in Lackawanna and Luzerne counties.[1] Since 1866 this region has been the leading shipper of coal.[2]

The Middle fields contain 130 square miles and their total length is 40 miles. These deposits lie principally in Luzerne county, but some sections are in Northumberland, Carbon, Schuylkill, and Columbia counties.[3]

The Southern field extends over 140 square miles and lies in Carbon, Schuylkill, and Dauphin counties. The greatest width is about 4 miles, at Pottsville, and the length is 55 miles.[3]

The first authentic record connected with anthracite coal history in the state is that in 1762 coal was discovered by the early pioneers in the Wyoming district, near the site of the present city of Wilkesbarre, and in 1769 it was first used by Obadiah Gore, a blacksmith. The presence of coal in the Schuylkill region was known in 1770, but the beds were not developed until 1834. From 1775 throughout the Revolutionary War anthracite coal, from the mines near Wilkesbarre, was shipped to the arsenal at Carlisle for use in the manufacture of war materials.[4]

Anthracite coal was first discovered in the Lehigh region, near Mauch Chunk, in 1791 and in the following year the Lehigh Coal Mine Company was formed and secured control of a large tract of coal land. It was not until 1802, however, that this company succeeded in floating coal laden arks down the Susquehanna and through the Lehigh and Delaware rivers to Philadelphia. Owing to the belief that the coal would not burn, no progress was made in the development of the coal trade for some years.[4]

In 1805-6 two brothers, by the name of Smith, settled in Plymouth, Pa., bought coal lands, and at once commenced shipping coal to points along the Susquehanna river, and although reports of the anthracite coal trade usually commence with 1820, when 365 tons of coal were shipped to Philadelphia from the Lehigh region, the real credit should be given to the Smith brothers, who had been shipping coal successfully for thirteen years prior to the date usually accepted as that beginning the record.

The trade from the Lehigh region was firmly established between 1820 and 1823. About 1825 the Schuylkill region was opened and in 1829 coal was being shipped from Carbondale.[5] From this time on the trade has rapidly increased until it has reached its present enormous proportions.

During the early days of anthracite coal mining a large percentage of the contents of the veins was not turned to commercial use. The methods of mining, transporting, and preparing were wasteful, and the operators were not economical in exploiting the veins, thinking them inexhaustible. In these early years of mining there was nothing to enforce economy in production, as the veins were rich, labor cheap, and prices comparatively high. These conditions existed until some years after the Civil War, when, owing to the diminution in profits, a more careful study was made of economical mining. Supplies were more carefully handled, the veins were operated more scientifically, and attention was given the great waste annually going on in the amount of coal sent to the dumps. Early in the fifties mining engineers in England had called attention to waste in mining, but it was not until many years later that mining engineers in this country turned their attention to the great waste in the anthracite coal fields. As a result of modern methods more coal is now being mined from the seams, better devices have been introduced in handling it, and better machinery put into the breaker.

A great economy in the use of coal was effected with a decrease in its size. Between 1870 and 1895 four or five sizes, theretofore unknown to the trade, were prepared for the market, and to-day they comprise 30 per cent of the coal shipped.

In 1890 attention was directed to the old culm heaps, so long such a disfiguring element in the coal regions. Previous to 1870 all sizes below chestnut were sent to the culm dump, and it has been estimated that in that year these dumps contained about 76,000,000 tons of marketable coal, and in the decade, 1870 to 1880, it has been estimated that about 19,500,000 more tons were thrown away. The matter of reclaiming the culm dumps was agitated. Despite opposition from many sources washeries were erected, and by the introduction of machinery, whereby still smaller sizes of coals could be prepared, a large percentage of the waste is now reclaimed and marketed.[6] The production of the 35 washeries reported at the census of 1902 amounted to 2,977,355 long tons.

In 1902 the 334 productive anthracite coal mines produced 36,940,710 long tons, the smallest annual production since 1886, while in 1901 the production was 60,242,560 tons. This decrease of 38.7 per cent was entirely caused by the strike in the anthracite regions, which lasted from May 12 to October 23, 1902.[7]

The following counties contributed to the state's output of anthracite coal for 1902: Carbon, Columbia, Dauphin, Lackawanna, Luzerne, Northumberland, Schuylkill, Sullivan, and Susquehanna. Among these Luzerne county ranked first in production, with

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[1] The Anthracite Coal Industry, page 5.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 418.

[3] The Anthracite Coal Industry, page 6.

[4] United States Geological Survey, Twenty-second Annual Report, 1900-1901, Part III, pages 74 to 76.

[5] Ibid., pages 75 and 76.

[6] The Anthracite Coal Industry, pages 213 to 227.

[7] Report on the Anthracite Coal Strike of 1902, page 37.

12,852,826 tons; Lackawanna second, with 10,779,268 tons; and Schuylkill third, with 7,704,202 tons.

The following table, compiled from reports of the United States Geological Survey, shows the annual production of anthracite coal from 1814 to 1902:

TABLE 5.—*Annual production of coal, anthracite: 1814 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
Total.	1,551,322,592	1843	1,556,753	1874	24,818,790
		1844	2,009,207	1875	22,485,766
1814	22	1845	2,480,032	1876	22,793,245
1815	50	1846	2,887,815	1877	25,660,316
1816	75	1847	3,551,005	1878	21,689,682
1817	100	1848	3,805,912	1879	30,207,793
1818	200	1849	3,995,334	1880	28,649,811
1819	350	1850	4,138,164	1881	31,920,018
1820	460	1851	5,481,065	1882	35,121,256
1821	1,322	1852	6,151,957	1883	38,456,845
1822	4,583	1853	6,400,128	1884	37,156,847
1823	8,563	1854	7,394,875	1885	38,335,974
1824	13,695	1855	8,141,754	1886	39,035,446
1825	42,988	1856	8,534,779	1887	42,088,197
1826	59,194	1857	8,186,567	1888	46,619,564
1827	78,151	1858	8,426,102	1889	45,544,970
1828	95,500	1859	9,619,771	1890	46,468,641
1829	138,086	1860	10,483,168	1891	50,665,431
1830	215,272	1861	9,799,654	1892	52,472,504
1831	217,842	1862	9,695,110	1893	53,967,543
1832	447,550	1863	11,785,320	1894	51,921,121
1833	600,907	1864	12,538,649	1895	57,999,337
1834	464,015	1865	11,891,746	1896	54,346,081
1835	690,854	1866	15,651,183	1897	52,611,680
1836	842,832	1867	16,002,109	1898	53,382,644
1837	1,071,161	1868	17,003,405	1899	60,418,005
1838	910,075	1869	17,083,134	1900	57,367,915
1839	1,008,322	1870	18,315,540	1901	67,471,667
1840	1,064,911	1871	19,342,057	1902	41,373,595
1841	1,182,441	1872	24,233,166		
1842	1,365,563	1873	26,152,837		

In connection with the discussion of past production, a consideration of probable future production is of great importance, and as bearing on this subject the following extract from the Report of the Anthracite Coal Strike Commission has been inserted:

> According to the estimates of the Pennsylvania geological survey, the amount of workable anthracite coal originally in the ground was 19,500,000,000 tons. The production to the close of 1901, as previously stated, amounted to 1,350,000,000 long tons, which would indicate that there remained still available a total of 18,150,000,000 tons. Unfortunately, however, for every ton of coal mined and marketed 1½ tons, approximately, are either wasted or left in the ground as pillars for the protection of the workings, so that the actual yield of the beds is only about 40 per cent of the contents. Upon this basis the exhaustion to date has amounted to 3,375,000,000 tons. Deducting this from the original deposits, the amount of anthracite remaining in the ground at the close of 1901 is found to be, approximately, 16,125,000,000 tons. Upon the basis of 40 per cent recovery this would yield 6,450,000,000 long tons. The total production in 1901 was 60,242,560 long tons. If this rate of production were to continue steadily the fields would become exhausted in just about one hundred years.
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> Mr. William Griffith, in a series of articles contributed to the Bond Record in 1896, considers that the estimates upon which the foregoing computations have been made were too liberal. His estimates of the amount of minable coal remaining at the close of 1895 was 5,073,786,750 tons.[1]
>
> In the six years from 1896 to 1901, inclusive, the production has been, approximately, 308,570,000 tons, which would leave still available for mining 4,765,216,750 tons. This supply, at the rate of production in 1901, would last a little less than eighty years. But as indicating how susceptible to error are human predictions, it is well to state that in his carefully prepared statement, published in 1896, Mr. Griffith assumes the limit of annual production would be reached in 1906, and would amount in that year to 60,000,000 tons.
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> This amount of production was reached in 1901, in just half the time predicted by Mr. Griffith, and the production of January, 1903, as recently reported, shows that the anthracite mines are capable of producing at a rate of 72,000,000 tons annually in their present state of development. It is not to be supposed, however, that the annual rate of anthracite production will continue practically uniform until the mines are exhausted and then suddenly cease. Portions of the fields have already been worked out, others are rapidly approaching total exhaustion, while others at the present rate of production will, it is calculated, last from seven hundred to eight hundred years. If we can assume the annual production will have reached its maximum limit at between 60,000,000 and 75,000,000 tons, and that the production will then fall off gradually as it increased, we may expect anthracite mining to continue for a period of from two hundred to two hundred and fifty years.
>
> This estimate is based upon the assumption that the available coal will remain at about 40 per cent of the reserves. How much this may be increased by better mining methods and the utilization of former waste material it is impossible to say. Already a large amount of fuel is being recovered from the old culm banks, and it seems safe to predict that the coal saved will, in the near future, equal 50 per cent of the contents of the fields worked. However we may make our estimates of future production, it is apparent that the maximum output has been almost if not quite reached. The production henceforth will be from lower levels and thinner seams than those previously worked. This will necessitate greater expense in mining and, consequently, higher prices for the fuel. With higher prices will necessarily follow more economy in consumption, greater restriction of the market, and the increased competition of other fuels. All conditions seem to combine for the conservation of the supply of anthracite coal.

Petroleum.—The Indians are known to have collected what was called "Seneca oil" from petroleum springs, and the indications are that at a much earlier period the Mound Builders not only gathered the oil flowing from springs, but even dug wells in Pennsylvania and dipped up the petroleum.[2]

The earliest mention of petroleum in the state appears to have been in 1721, and on a map published in 1755 the word "petroleum" appears near the mouth of what is at present known as Oil creek, on the Allegheny river. From this time mention of the Seneca oil, naphtha, or rock oil, as it was variously called, became more frequent.[3]

The real beginning of the petroleum industry dates from the discovery in 1858 of Drake's well, near Titusville, in Crawford county. The success of this well, which produced 25 barrels daily, at that time an enormous quantity, occasioned a period of great excitement, and during 1859 and the next few years western Pennsylvania was a scene of indescribable activity and speculation. Large numbers of wells were sunk along Oil creek, French creek, and the Allegheny river; adventurers flocked thither from all parts of the country, and what shortly became known as the "oil region" was transformed from an almost unbroken forest into camps and towns.

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[1] Mr. Griffith's estimate includes all workable coal in the Northern field having beds 4 feet thick and yielding 3 feet of clean coal. In the other fields it includes seams 3 feet in thickness, capable of yielding 2¼ feet of clean coal. It excludes the culm piles, mine pillars, etc. The acreage of each bed is multiplied by the thickness of the seams in feet and thus reduced to foot-acres. Each foot-acre was estimated to produce 650 tons of coal, and on the 1st of January, 1896, the unworked areas were estimated to contain 7,805,826 foot-acres, or 5,073,786,750 tons

[2] One Hundred Years of American Commerce, Vol. I, page 206.

[3] Transactions of the American Institute of Mining Engineers, Vol. VIII, pages 20 and 21.

The first flowing well was struck early in 1861. Up to that time all of the oil was drawn from the wells by pumps. This well yielded 300 barrels per day and flowed for fifteen months. Soon after the largest flowing well ever operated in America, the Phillips, was struck, giving 3,000 barrels per day. The discovery of these "gushers" stimulated prospecting and enormously increased the production, with a corresponding decline in prices.

That the productive territory need not necessarily underlie the valleys and the river bottoms was demonstrated in 1862. In the succeeding years wells were struck on the high plateaus of Clarion, Butler, Armstrong, McKean, and Warren counties, the Clarion-Butler, or Southern, field being discovered in 1870.

In 1874 the great Bradford field was discovered. This field includes McKean county, Pa., and Allegany and Cattaraugus counties, N. Y., and has been one of the greatest oil producing fields in the history of the petroleum industry.

The other Pennsylvania oil fields are known as the Middle, including Warren and Forest counties; the Lower, or Southern, including Venango, Clarion, Butler, Beaver, and Lawrence counties; and the Washington, or Southwestern, including Allegheny, Washington, and Greene counties.[1]

For many years, in fact up to 1885, the Pennsylvania field, which includes New York, was looked upon as the undisputed source of supply of petroleum for the world,[2] and up to 1903 this field had produced 628,401,456 barrels, or 53.9 per cent of all the crude petroleum produced in the United States since 1859.

In 1891 the maximum annual output in the petroleum production of the state was reached. Since 1894 Ohio has surpassed Pennsylvania in the production of petroleum, and in 1902 the state ranked fifth, being outranked by Ohio, Texas, California, and West Virginia.[3]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of petroleum from 1891 to 1902:

TABLE 6.—*Annual production of petroleum: 1891 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1891	31,424,206	1897	17,982,911
1892	27,149,034	1898	14,743,214
1893	19,283,122	1899	13,053,603
1894	18,077,559	1900	13,258,202
1895	18,231,442	1901	12,625,378
1896	19,379,201	1902	12,063,880

Natural gas.—The largest area of natural gas in the country lies within the state of Pennsylvania. The pools are thickly scattered to the west of an imaginary line drawn from the southeast corner of Greene county to the northeast corner of Potter county, including an area of about one-third of the entire state. The counties cut by this imaginary line and all to the west of it produce more or less natural gas.[4]

The presence of natural gas in Pennsylvania was undoubtedly known early in the eighteenth century, but the first recorded use of it in this country was in 1824, when a supply from a well was used to illuminate the village inn at Fredonia, New York.[5]

Early in the history of oil well drilling, which began in 1859, the gas which always escaped from oil wells was used as a fuel for firing the boilers on the drilling engines; it was soon being piped to houses for use as light and fuel. In 1872 the first natural gas plant was built, and a 2-inch line run from the Newton well to furnish gas for domestic purposes in Titusville, Pa., about five and one-half miles distant. It was not, however, until 1874 that the great value of natural gas as a manufacturing fuel was demonstrated. After that date its use rapidly increased until by 1890 it was estimated that natural gas had annually displaced as a fuel 10,000,000 tons of coal.[5]

Before the value of natural gas as a fuel was fully appreciated the extensive fields about Pittsburg had been discovered. The first well in this field was opened November 4, 1878, but no attempt was made to use the product of this well for four years, and very little drilling was done in the field until 1884.

About 1890 the territory south of Pittsburg began to be developed, although gas had already been discovered and used to a considerable extent in the vicinity of Washington, Washington county.

In the early days of the production of natural gas the original "rock" pressure of the wells was so great and the productive area so extensive that the supply was believed to be practically inexhaustible, and as a result it was wasted in the most extravagant manner. However, between 1885 and 1890 the earlier fields began to show unmistakable evidences of depletion. As a result the gas became more valuable and meters and other saving appliances were introduced.[6]

In 1902 the value of the natural gas produced in Pennsylvania amounted to $14,352,183, or 46.5 per cent of the value of the entire production in the country for that year. The product came from 5,408 wells. The 1902 production is the greatest in the history of the state since 1885, with the exception of 1888, when it reached its highest point.

Cement.—A large mass of cement rock of excellent quality was exposed near Williamsport, in Lycoming county, in 1831, during the construction of a canal between Lock Haven, Clinton county, and Muncy, Lycoming county. A plant was immediately erected for the manufacture of such cement as should be required in the construction of the locks and dams of the canal, and until the completion of the canal, this plant flourished. After this, however, the industry continued only in a small way, as the local demand for cement was not great. In 1850, during the construction of the Lehigh canal, from Easton, Northampton county, to Mauch Chunk, Carbon county, the cement rock, of which such large quantities have been used in this valley, was discovered.

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[1] The Mineral Industry, 1893, Vol. II, pages 509 to 511.

[2] One Hundred Years of American Commerce, Vol. I, page 208.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 543 ff.

[4] Ibid., page 639.

[5] The Mineral Industry, 1901, Vol. X, pages 464 and 465.

[6] Ibid., pages 476 and 477.

The manufacture of cement for the Lehigh canal was commenced at Siegfried, in Northampton county, and the product proved to be of excellent quality. In 1865 a large natural rock cement establishment was erected at Coplay, in Lehigh county. While the product of this plant was of good quality, competition led to experiments in the manufacture of an artificial or Portland cement, and in 1870 a small quantity of this important material was produced. This was the first plant to successfully make Portland cement in this country. In 1878 there were four plants manufacturing cement on the Lehigh river. Their success was followed by a steady growth of the industry, and this locality became the leading center of production of artificial cement. This position it still holds, contributing more than one-half the entire output of the United States.[1]

The development of this industry was, however, comparatively slow, caused undoubtedly by the increased imports of artificial cement, and in 1891 the output of Portland cement from the 6 plants in Lehigh county reached only 268,500 barrels.[2] From this time on the annual production of Portland cement in Pennsylvania has steadily increased, and in 1902 it reached the highest point in its history. The production of Portland cement for that year in the United States was 16,691,055 barrels, of which Pennsylvania contributed 8,563,926 barrels, or 51.3 per cent.

Of the 17 productive plants in the state in 1902, 7 were located in Northampton county, 8 in Lehigh, and 1 each in Berks and Lawrence. Portland cement alone was manufactured by 11 of these plants, while the remaining 6 made both artificial and natural-rock cement, the production of the latter kind of cement amounting to but 796,876 barrels. The value of the entire cement production of the state was $10,223,267.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of both Portland and natural-rock cement, from 1890 to 1902:

TABLE 7.—*Annual production of cement: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

[Barrels.]

YEAR.	Portland.	Natural rock.	YEAR.	Portland.	Natural rock.
1890	221,000	555,000	1897	1,579,724	[1] 775,000
1891	268,500	695,000	1898	2,095,111	[1] 499,956
1892	300,840	664,504	1899	3,217,965	511,404
1893	285,317	567,110	1900	4,984,417	687,838
1894	437,106	606,812	1901	7,091,500	942,364
1895	504,270	600,895	1902	8,770,454	796,876
1896	825,054	608,000			

[1] Barrels of 300 pounds.

Limestones and dolomites.—Large quantities of gray or bluish gray stone, which because of its color and texture is unsuited to any form of ornamental work, are found in the Lower Silurian formations in Montgomery, Lancaster, and Chester counties. This stone has been extensively quarried for general building purposes and for foundations and bridge abutments. Limestone is also quarried for local use in Berks, Lebanon, Dauphin, Lancaster, York, and Cumberland counties, the Lancaster county stone being very durable. The stone quarried at York, in York county, is very fine grained, compact, and of a deep blue-black color, and if it were not uneven in texture might make a fine marble.[3]

In 1902 there were 907 limestone quarries in Pennsylvania, located in 43 different counties, among which Lawrence county was first in the value of its limestone production, Montgomery county was second, and Chester county third. The value of the limestone production in Pennsylvania in 1902 was $5,458,433, which gave the state first rank among the limestone producing states of the country. The value of the limestone quarried in the state for building purposes in this year amounted to $209,215, the balance of the production being used mainly for making lime, but also in road-making, railroad ballast, etc.

Slate.—Little is known of the beginning of American slate quarrying. Probably the first quarry opened was located in the Peach Bottom region in York county, Pa., about 1800. Another quarry was opened at Upper Mt. Bethel, Northampton county, in 1811, and the Franklin quarry located near Slatington, in Lehigh county, was being operated in 1846. On the southeastern side of the Blue or Kitatinny mountains, in Northampton county, is located the most important slate producing area of America.[4] This area forms a belt which extends throughout the entire northern part of Northampton and Lehigh counties and thence, in a gradually narrowing band, in a southwesterly direction through Berks, Lebanon, Dauphin, Cumberland, and Franklin counties.[5]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 804 and 805.

[2] Ibid., pages 805 to 807.

[3] Stones for Building and Decoration, by George P. Merrill, page 321.

[4] The Mineral Industry, 1897, Vol. VI, pages 593 to 595.

[5] Stones for Building and Decoration, pages 192 to 194.

This area has been divided into four regions—the Bangor, the Pen Argyl, the Lehigh, and the Hard Vein. Of these regions the Bangor is the most important, and the No. 1 Bangor slate is generally regarded as the standard in this country.[1] The slate of this region is soft and tough, and when free from ribbons is generally of high quality and noted for its durability. Aside from its use for roofing the material from the Bangor region is also used in making blackboards, school slates, and mantels. The slate of the Pen Argyl region closely resembles the Bangor slate. Almost the entire output is used for roofing purposes. In area the Lehigh region is the largest, and its output, besides being used for roofing purposes, also makes excellent blackboards. The slate from the Hard Vein region is harder than that from any of the other regions.[2]

In 1902 the 91 productive slate quarries of Pennsylvania were located in Northampton, Lehigh, and York counties. The total output of slate in the state for the year was valued at $3,547,322, of which $2,398,964, or 67.6 per cent, was contributed by Northampton county. Of the entire output the value of that used as roofing slate amounted to $3,001,545, the rest of the product being made into school slates, blackboards, mantels, tilings, etc.

In 1902 the output of slate in the United States amounted in value to $5,696,051, of which amount Pennsylvania contributed 62.3 per cent. In this branch of mineral industry Pennsylvania has long held first place.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of roofing slate from 1884 to 1902:

TABLE 8.—*Annual production of roofing slate: 1884 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Squares.	YEAR.	Squares.
1884	339,004	1894	411,730
1885	345,660	1895	436,667
1886	360,805	1896	431,324
1887	390,439	1897	657,092
1888	435,000	1898	571,296
1889	476,098	1899	711,138
1890	(1)	1900	788,571
1891	507,824	1901	853,028
1892	550,000	1902	908,206
1893	364,051		

(1) Not reported.

Sandstones and quartzites.—The principal quarry in the state in the belt of Triassic sandstone is located in Dauphin county. The texture of the rock is of medium fineness and the color is a deep bluish brown. The stone compares very favorably with any other Triassic stones and is now in very general use in all principal eastern cities.

The Carboniferous sandstones of Pennsylvania, although occasionally of good quality, are little quarried except for local use. The stones of Subcarboniferous formation have been but little quarried for purposes of construction, although at Franklin, in Venango county, a fine grained, evenly bedded buff stone, resembling to some extent the buff variety of the Berea grit, is quarried for sidewalks and buildings in the vicinity.

Aside from the Triassic stones those quarried from the Devonian formations are the most important. The stone from this formation, known as the Wyoming Valley stone, agrees very closely in general appearance with much of the bluestone quarried in New York state.[3]

The value of the output of sandstones and quartzites, including bluestones, quarried in Pennsylvania in 1902 amounted to $2,800,108, which gives to the state first rank in the production of this class of minerals. The 1902 production exceeded that for 1901 by $737,026.

Iron ore.—The magnetite variety of iron ore, as well as the red and brown hematites and the carbonate, is found in various localities within the state in deposits of more or less richness. The brown hematites are apparently divided into two series, starting in the northern section of the state, and running southwest in nearly parallel lines. The magnetites occur between these two belts. The carbonate variety of iron ore is found in the western portion of the state, and between the carbonate and the brown hematite belts are found the red hematites.[4]

The celebrated Cornwall mines of magnetic ore, containing one of the largest and richest deposits of this variety of iron ore in the country, are located in Lebanon county, 5 miles south of Lebanon and about midway between Reading, on the Schuylkill river, and Harrisburg, on the Susquehanna.[5] The area of ore here exposed measures about 4,000 feet in a direction nearly east and west, with a breadth of from 400 to 800 feet, and includes three hills, separated by two valleys, running north and south. These mines have been among the most productive iron ore properties in the country, having produced up to 1889 over 10,000,000 tons.[6]

The limestones of the Cumberland valley are very rich in limonite, or brown hematite ores, which form a large part of the charges of the many blast furnaces situated on their outcrops. The mines from which these ores are obtained are really only pits or quarries, the ores being extracted by means of picks and shovels.[7]

While the presence of iron ore in Pennsylvania was undoubtedly known at an early date, it is not probable that any deposits were developed to any considerable extent until the latter part of the seventeenth or the early years of the eighteenth century.

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[1] The Mineral Industry, 1897, Vol. VI, page 595.

[2] Stones for Building and Decoration, pages 192 to 194.

[3] Stones for Building and Decoration, pages 159 to 162.

[4] United States Geological Survey, "Mineral Resources of the United States," 1891, page 20.

[5] Transactions of the American Institute of Mining Engineers, Vol. XIV, page 873.

[6] A Treatise on Ore Deposits, by J. Arthur Phillips, F. R. S., pages 820 and 821.

[7] Transactions of the American Institute of Mining Engineers, Vol. III, page 410.

The first recorded instance of the manufacture of iron within the state was in 1692, and the first successful ironworks were established in 1716, on Manatawny creek, in Berks county.[1] In the same year the development of the iron ore mines of the Schuylkill valley began.[2] About 1720, a furnace, located in the heart of one of the richest deposits of magnetic iron ore in the country, was erected on Ironstone creek, Colebrookdale township, in Berks county.[3] The celebrated deposits of magnetic iron ore of Cornwall hills are said to have been worked about 1735,[4] and in 1742 the Cornwall furnace was built. The mine was described, a few years later, as being rich and abundant. During the War of the Revolution, Cornwall furnace cast cannon and shot and shell for the Continental Army, and it was still in operation as late as 1882.[4]

In 1902 there were 42 operators in Pennsylvania who reported 47 productive iron mines, having an output of 822,932 long tons, which gave to the state sixth rank in quantity of iron ore produced.

In the output of the different varieties of iron ores the state ranks first in magnetite, with a production of 616,645 tons; sixth in brown hematite, with 185,846 tons; and twelfth in red hematite, with 20,441 tons.[5]

In 1902 the following counties contributed to the state's output: Berks, Bucks, Center, Cumberland, Huntingdon, Lancaster, Lebanon, Lehigh, Northampton, Perry, Snyder, Union, and York. Among these Lebanon county ranks first, with 594,177 tons, or 72.2 per cent of the state's production, drawn entirely, in 1902, from the celebrated Cornwall mine. Center county ranks second with a production of 64,382 tons, and Lehigh county third with 58,508 tons.

Pennsylvania showed a decrease of 217,752 tons in the production of iron ore in 1902, as compared with 1901. The value of the state's production was $1,225,453, or an average value of $1.49 per ton.

The following table, compiled from reports of the United States Geological Survey, shows the annual production of iron ore from 1889 to 1902:

Table 9.—*Annual production of iron ore: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1889	1,560,234	1896	747,781
1890	1,361,622	1897	723,742
1891	1,272,928	1898	773,082
1892	1,084,047	1899	1,009,327
1893	697,985	1900	877,684
1894	532,087	1901	1,040,684
1895	900,340	1902	822,932

Siliceous crystalline rocks.—Although Pennsylvania leads among the stone producing states, it furnishes comparatively little in the way of granitic rock. Nearly all of the granite quarries in the state are in the district extending from the Delaware river, at Trenton, to the state line, near the Susquehanna, thus lying south of the limestone valley of Montgomery county. The largest of these quarries are in the vicinity of Philadelphia, and the product, which is for the most part a dark gray hornblende gneiss, is used particularly for the rough work of foundations.[6]

In 1902 siliceous crystalline rocks were quarried in Adams, Berks, Bucks, Chester, Delaware, Fayette, Lancaster, Lehigh, Montgomery, and Philadelphia counties, the total output amounting in value to $661,062. Among the counties referred to, Berks ranks first in the output of this rock, Delaware second, and Philadelphia third.

Clay. The refractory clays and shales of the coal measures of Pennsylvania constitute one of its most important mineral resources, especially in the western part of the state. Among the more important of these are the Bolivar fire clay, under the upper Freeport Coal Measures, and a fire clay in Beaver county, underlying the Kittanning coal. Another important bed occurs in Indiana, Cambria, and Beaver counties.[7]

The deposits of kaolin near Brandywine Summit, in Delaware county, contain some of the oldest mines in the country. In southeastern Pennsylvania the decay of schistose or limestone rocks at the contact of the Cambrian and Silurian has yielded some white residual clays which, after washing, are suitable for white earthenware manufacture.[8]

In the manufacture of brick and tile Pennsylvania leads, but in the production of clay products as a whole the state ranks second. In 1902 clay was produced in the state by 13 counties, and was valued at $288,811.

The following table, compiled from reports of the United States Geological Survey, shows the annual production of clay from 1900 to 1902:

Table 10.—*Annual production of clay: 1900 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.
1900	140,734
1901	144,547
1902	161,546

Mineral pigments, crude.—The mineral substances included under this heading are the ores used in the manufacture of metallic paint, such as ocher, umber, sienna, venetian red, etc.

The "paint bed" at Lehighgap was discovered in 1856. This bed outcrops along the southern border of

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[1] Iron in All Ages, by James M. Swank, page 164.

[2] United States Geological Survey, "Mineral Resources of the United States," 1883–84, page 263.

[3] Iron in All Ages, pages 167 and 168.

[4] Ibid., pages 182 and 183.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 43.

[6] Stones for Building and Decoration, page 81.

[7] The Mineral Industry, 1901, Vol. X, page 114.

[8] The Clays of the United States East of the Mississippi River, by Henrich Ries, page 49.

Carbon county, about 27 miles north of Bethlehem, in a well defined ridge of Oriskany sandstone, known as Stony Ridge. The bed, however, is not continuous throughout the extent of this ridge. The ore is bluish gray, resembling limestone, and is very hard and compact.[1]

In 1902 there were 12 mines in Pennsylvania which produced crude mineral pigments, located in the counties of Berks, Carbon, Lawrence, Lehigh, Lycoming, Luzerne, Montgomery, Northampton, and Wyoming. The output amounted to 20,807 short tons, valued at $246,346. Carbon county was the greatest contributor to this total, with Lehigh county next, and Northampton county third. The production for the United States amounted to 35,479 short tons, of which Pennsylvania contributed 58.6 per cent.

Silica sand.—The glass sand mined in Pennsylvania in 1902 came from the counties of Berks, Butler, Chester, Fayette, Lancaster, Lebanon, Mifflin, Somerset, and Westmoreland. It occurs both as a sandstone, which requires crushing and preparation before use, and as a sand, which quickly disintegrates when quarried and exposed to air and moisture.[2]

The output of silica sand in the state in 1902 was 268,262 short tons, of which Mifflin county contributed 76,000 tons, or 28.3 per cent, leading the remaining eight counties producing this mineral. The state's output was 60.2 per cent of that for the United States, which was 445,903 short tons.

Marble.—The only quarries of merchantable marble at present worked within Pennsylvania lie in the belt of Lower Silurian limestone, which extends from Sadsbury, in Lancaster county, in an easterly direction through Chester county, and through the western half of Montgomery county. The prevailing colors of the stone throughout the larger portion of this area are yellowish or bluish, and as a consequence are suitable only for making quicklime or for ordinary rough building purposes.[3]

Quarries were first opened in Montgomery county about the time of the Revolution, and up to 1840 this stone was almost the only material used in the better class of stone buildings in and about Philadelphia. Increased transportation facilities about this date brought the better varieties of eastern marbles into the Philadelphia market, and as a consequence the Montgomery county marble was not in as great demand.[3]

In 1902 there were only three productive quarries in the state, located one each in Chester, Dauphin, and Montgomery counties. The value of the output from these quarries was $160,423; of this amount $110,977 represented the value of that which was dressed for building purposes, and $24,000 that dressed for monumental purposes.

Feldspar.—Pennsylvania is one of the leading states in the production of feldspar, large deposits of this mineral occurring in the serpentines of Chester county and in the granitic rocks of Delaware county. Nearly all the feldspar quarries are worked as open pits, but in a few instances underground tunnels have been employed. The largest quarry is located near Elam, in Delaware county, and has been productive since 1883. This quarry has been worked to a depth of 100 feet, with some underground workings extending 300 feet or more along a vein which the open working shows to be 60 to 70 feet wide.[4]

In 1902 there were twelve productive feldspar quarries in the state, all of which were located in Chester and Delaware counties. The entire output amounted to 15,121 short tons, or 33.4 per cent of the production of the United States for 1902. The value of the state's output amounted to $115,699.

All other minerals.—The American millstone varies from a sandstone to a quartz conglomerate, and the rock from which it is made occurs along the eastern slopes of the Appalachian mountains from New York to North Carolina, and is known by various names.[5] In Pennsylvania it is called "Cocalico," and is found in Lancaster county. The three productive quarries in 1902 had an output valued at $1,978.

The crystalline quartz produced in Pennsylvania in 1902 came from Chester county and was largely used in the manufacture of sandpaper. No figures can be shown for the single operator without disclosing individual operations.

The mineral worked throughout the entire Appalachian region, either for pottery or under the name of "flint," and included in this report is quartz. It is used chiefly in the manufacture of pottery and porcelain, although some of it is used in soapmaking and wood fillers. The four productive quarries of the state in 1902 were located in Adams, Chester, and Lancaster counties, and had an output valued at $42,721, or 29.6 per cent of that for the United States.

The garnet found in Pennsylvania is of the ruby or rose colored variety, and is used by the manufacturers of shoes as an abrasive. The deposits are found in Delaware county and occur in a quartzose gneiss.[6] There was but one operator in the state in 1902.

Graphite is produced commercially only in Chester and Berks counties. In the mine near Chester Springs, in Chester county, the mineral occurs in two layers of disintegrated mica schist, and the rock is so distinguished that most of the graphite material can be removed without blasting. In 1902 both the productive properties were located in Chester county.[1]

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[1] Transactions of the American Institute of Mining Engineers, Vol. XIX, pages 322 to 325.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 1011.

[3] Stones for Building and Decoration, pages 222 and 223.

[4] The Mineral Industry, 1898, Vol. VII, pages 267 and 268.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 878 and 879.

[6] The Mineral Industry, 1897, Vol. VI, page 21.

The output of the phosphate rock mines of Pennsylvania, located in Juniata county, was first reported in 1899 by the United States Geological Survey, and amounted to 2,000 tons, valued at $9,000. In 1902 there was but one operator.

The value of the output classed under "precious stones" was $5,000, and consisted of specimens of anthracite and iron ore suitable for making into ornaments.

The two soapstone quarries of the state productive in 1902 were located in Montgomery and Northampton counties; the output is put on the market as ground talc.

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[1] The Mineral Industry, 1901, Vol. X, page 369.

RHODE ISLAND.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Rhode Island for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Siliceous crystalline rocks.	All other minerals.[1]
Number of mines or quarries	22	19	3
Number of operators	22	19	3
Salaried officials, clerks, etc.			
Number	56	54	2
Salaries	$56,150	$55,310	$840
Wage-earners:			
Average number	667	638	29
Wages	$435,224	$421,608	$13,616
Miscellaneous expenses	$25,938	$22,898	$3,040
Cost of supplies and materials	$85,127	$71,908	$13,219
Value of product	$774,611	$734,623	$39,988

[1] Includes operators as follows: Graphite, 1; limestones and dolomites, 2

Rhode Island has held for many years a very prominent position among granite producing states on account of the superiority of its granite for monumental purposes, particularly the stone that is quarried at Westerly and vicinity.[1]

In previous years some coal which was classed as anthracite was mined in the eastern part of the state. This product is not in reality an anthracite coal, but is graphitic, and, in the last few years, has been included with the graphite production.[2] It is of a structure between scaly and granular, and contains, in selected samples, as much as 52 per cent carbon.[3]

The following minerals also occur in the state, but were not mined in commercial quantities in 1902: Asbestos, galenite, garnet, iron ore, talc and soapstone, whetstones, copper pyrite, sandstone, manganese ore, agate, jasper, and molybdenum in Providence county, and serpentine in Providence and Newport counties.[4] Deposits of ilmenite, mica, monazite, and rutile also occur, but were not exploited in 1902.

The following table shows for 1900 the value of the products of manufactures closely allied to or based upon the products of mines and quarries, and also the total value of all manufactures for the year:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$184,074,378
Based upon products of mines or quarries		
Chemicals and allied products	$871,485	
Clay, glass, and stone products	1,430,960	
Iron and steel and their products	18,107,330	
Metals and metal products, other than iron and steel	22,752,825	
Miscellaneous industries	8,021,006	
		51,183,606
All other		132,890,772

The value of the products of the manufacturing industries of the state for 1900, as shown in Table 2, was $184,074,378, to which amount those branches based primarily on the products of mines and quarries contributed $51,183,606, or 27.8 per cent. During the same year 98,813 wage-earners, receiving $41,114,084, were employed in all branches of manufacture. In 1902 the mines and quarries gave employment to 667 wage-earners, who were paid $435,224 in wages. The combined industries, therefore, gave employment to 99,480 wage-earners and paid $41,549,308 in wages. Manufactures contributed 99.3 per cent of the wage-earners and 99 per cent of the wages, while mines and quarries contributed seven-tenths of 1 per cent of the wage-earners and 1 per cent of the wages.

The following table shows the value of the state's annual production of siliceous crystalline rocks from 1890 to 1902:

TABLE 3.—*Value of annual production of siliceous crystalline rocks: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Value.	YEAR.	Value.
1890	$931,216	1897	$629,561
1891	750,000	1898	320,212
1892	600,000	1899	400,128
1893	509,799	1900	444,316
1894	1,211,439	1901	501,698
1895	968,473	1902	734,623
1896	746,277		

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[1] United States Geological Survey, Twentieth Annual Report, Part VI, continued, page 279.

[2] Ibid., "Mineral Resources of the United States," 1902, page 292.

[3] Ibid., page 977.

[4] Ibid., 1887, page 785.

Siliceous crystalline rocks.—The mineral wealth of the state consists principally in its deposits of granite, which for the most part lie west of the bay in Providence, Kent, and Washington counties, although some stone is quarried in Newport county. Beginning in 1890 with an output valued at $931,216, the production decreased steadily until 1893; then increased in 1894 to $1,211,439, the maximum in the history of the state. The value of the output decreased again gradually until 1898, when the lowest value, $320,242, in the last thirteen years was reached. Since 1898 there has been again a gradual increase, the value in 1902 amounting to $734,623. This output was obtained from 19 quarries, 9 of which were located in Washington county, 6 in Providence, 3 in Newport, and 1 in Kent. The quarries in Washington county produced the greater part of the monumental stone of the state, 8 of the 9 quarries in this county showing this class of granite as their principal product. The output of the remaining quarries of the state was used chiefly for building stone, but some was also used as paving, curbing, and crushed stone for roadmaking and concrete, and some was sold as riprap and rubble stone.

The value of the stone used for monumental work in 1902 was $550,719, or 75 per cent of the total, and in 1901, $291,805, or 58.2 per cent of the total value for that year. For the years 1898, 1899, and 1900 no separation was made of rough stone, but the chief product was dressed stone for monumental work.

The importance of the state as a producer of monumental stone from 1898 to 1902 is shown in Table 4.

TABLE 4.—*Value of granite for monumental work for the United States and for Rhode Island, and per cent that Rhode Island forms of the United States: 1898 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	United States.	Rhode Island.	Per cent of total.
1898	$1,462,598	$204,739	14.0
1899	1,687,967	145,000	8.6
1900	1,598,842	232,111	14.5
1901	2,715,225	291,805	10.7
1902	3,998,911	550,719	13.8

The state, in 1898, was exceeded in value of its output of monumental stone only by Vermont and New Hampshire; its production was 14 per cent of the value for the United States. In 1899 the value of the production was 8.6 per cent of the total for all states, Rhode Island ranking fourth, being exceeded by Vermont, Massachusetts, and New Hampshire. In 1900, 1901, and 1902 the state ranked third, producing for the three years respectively 14.5, 10.7, and 13.8 per cent of the production of monumental stone in the United States. Vermont and New Hampshire led Rhode Island in 1900; Vermont and Massachusetts in 1901 and 1902.

All other minerals.—The only producer of graphite in the state is the Rhode Island Graphite Company, of Providence. The output has been combined with that of limestones and dolomites to avoid disclosing the operations of any single establishment.

Only two limestone quarries reported production in 1902, both located at Limerock, in Providence county. Almost the entire product was consumed in lime manufacture, though a small quantity was used for fluxing purposes.

SOUTH CAROLINA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of South Carolina for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Phosphate rock	Siliceous crystalline rocks.	Clay.	All other minerals.[1]
Number of mines or quarries	38	10	15	8	5
Number of operators	42	10	14	8	10
Salaried officials, clerks, etc.:					
Number	148	80	41	14	13
Salaries	$126,992	$65,401	$32,841	$11,300	$17,450
Wage-earners:					
Average number	2,694	1,198	815	198	483
Wages	$891,737	$435,553	$351,066	$45,118	$60,000
Miscellaneous expenses	$106,890	$65,157	$31,047	$3,185	$7,501
Cost of supplies and materials	$342,379	$162,836	$131,771	$11,612	$36,160
Value of products	$1,834,134	$950,208	$598,848	$107,325	$177,753

[1] Includes operators as follows: Gold and silver, 3; limestones and dolomites, 1; manganese ore, 1; precious stones, 5 (no mines).

The state ranked thirty-ninth in 1902 in the value of products of mines and quarries, with a total of $1,834,134. The range of mineral industry is confined in the main to three or four different products. Notable among these is phosphate rock, in the mining of which the state still takes high rank, though in former years it furnished nearly all of the production in the United States. Granite of high grade is found in abundance, and the kaolin beds of Aiken county are extensively worked. Gold ore, while not distributed over a wide area, is successfully mined.

Among the minerals of the state which were not mined commercially in 1902 are the following: Asbestos occurs near Glenn Springs and Cedar Springs in Spartanburg county, and in Pickens county. Fuller's earth is found in white, gray, yellow, pink, and black. The deposits extend in a broken, sinuous band across almost the entire state, and in some localities they approximate 40 feet in thickness.[1] Graphite has been found in the northeast corner of Spartanburg county and at Paris mountain in Greenville county. Iron ores occur in many sections of the northern and northwestern part of the state, many of the banks having been worked. The counties in which the principal deposits are located are York, Union, Spartanburg, Greenville, Abbeville, Lexington, Pickens, and Chesterfield. Iron pyrites are abundant in Spartanburg and York counties, and occur also in Chesterfield and Lancaster. Monazite has been found and mined in the extreme northern part of the state, especially in Spartanburg county. Talc is found in Abbeville, Lexington, Chester (where it has been worked), Anderson, Spartanburg, Union, and Pickens counties. Other minerals occurring in the state in varying quantities are: Bismuth, ocher, copper, pyrites, galena, brown coal, malachite, phosphate of lead, and barytes.[2]

The relative importance of manufacturing industries closely allied to or based on mining industry using as raw material the products of the mine or quarry is shown in the following table:

TABLE 2.—*Manufactures based primarily upon products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$58,748,731
Based upon the products of mines or quarries		
Chemicals and allied products	$4,882,506	
Clay, glass, and stone products	888,965	
Iron and steel and their products	412,493	
Metals and metal products, other than iron and steel	291,845	
Miscellaneous industries	596,505	
		7,072,314
All other		51,676,417

The total value of the products of the manufacturing industries based primarily upon mining and quarrying was, as shown by Table 2, $7,072,314, or 12 per cent of the total value of the product of all manufacturing industries in the state in 1900. The value of the output of the mines and quarries of the state in 1902 was $1,834,134, or 3.1 per cent of the combined value of the product of manufacturing and mining. In 1900 there were employed in all branches of manufactures 48,135 wage-earners, who were paid $9,455,900 in wages. In 1902 there were employed in the mines and quarries 2,694 wage-earners, who received $891,737 in wages. By combining the figures of these two branches of industry and comparing, it is disclosed that 94.7 per cent of the wage-earners, receiving 91.4 per cent of the wages, were employed in manufacturing, while 5.3 per cent of the wage-earners, receiving 8.6 per cent of the wages, were employed in mining.

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[1] Clays of South Carolina, by Earle Sloan, page 60.

[2] United States Geological Survey, "Mineral Resources of the United States," 1887, page 786 ff.

The following table shows the value of the annual production of the principal minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Phosphate rock.	Siliceous crystalline rocks.	Clay.
1890	$2,875,605	$47,614	(1)
1891	2,948,738	50,000	(1)
1892	1,877,709	60,000	(1)
1893	2,157,014	95,448	(1)
1894	1,745,576	45,909	(1)
1895	1,411,032	22,068	(1)
1896	1,181,649	55,850	(1)
1897	986,572	37,820	$93,200
1898	1,107,272	169,518	123,250
1899	1,078,069	361,034	94,899
1900	1,041,970	500,802	79,900
1901	961,840	295,084	143,700
1902 [2]	950,208	598,848	107,325

[1] Not reported separately. [2] Census figures.

Phosphate rock.—The phosphate rock belt of the state is 70 miles long and 30 miles wide, extending from the mouth of the Broad river, near Port Royal, in the southeast, to the headwaters of the Wando river in the northeast. Its major axis is parallel with the coast, and its greatest width is in the neighborhood of Charleston.[1] The principal deposits are located in Berkeley, Dorchester, Charleston, Colleton, and Beaufort counties.[2] So far as occurrence in commercial quantities is concerned, their distribution is confined within narrow limits. They are found at the bottom of rivers, 20 to 30 feet in depth, and on land they occur at an elevation but slightly above mean tide. The rock of commerce occurs always above the marl and is known as land or water rock, according to its location. The water rock is darker in color and harder than the land rock, and is frequently found in a layer or sheet of cemented or tightly compacted nodules overlying the marls at the bottom of rivers and creeks, where it either forms the bottom itself or is overlaid by a deposit of mud of greater or less depth. The land rock is found generally at a depth of from 2 to 10 feet below the surface of the soil. It occurs in masses or nodules varying in size from that of a potato to several feet in diameter. These nodules are rounded, rough, indented, and frequently perforated with irregular cavities, and in color they vary from olive or bluish black to a yellowish or grayish white. By analysis they are found to contain 55 to 61 per cent of phosphate of lime, 5 to 10 per cent of carbonate of lime, 2 to 10 per cent of organic matter and water, with small quantities of fluorine, iron, magnesia, alumina, sulphuric acid, and sand. This land rock is found in a loose layer varying from a few inches to 30 feet in depth, and averaging about 8 inches. It occurs in sand, mud, clay, or peat, and is often intermingled with numerous remains of land and marine animals. Among the former are the bones of the mastodon, elephant, tapir, deer, and the domestic animals, the horse, cow, and the hog.[3]

The great bed, or series of beds, of phosphate rock which was later destined to supply the civilized world with the chief part of all the phosphate of lime used in the manufacture of commercial fertilizers was discovered, or rather its value was first definitely established, in 1867.[4] To Dr. St. Julian Ravenel, of Charleston, this honor has been accredited. However, forty years before, Robert Mills forecasted this discovery, saying, that "besides gypsum, we may also expect to find in that part of the state (the Atlantic seaboard), the same kind of marl which has so greatly contributed to enhance the value of the poor lands of New Jersey, by the fertility which it imparts to the soil."[5]

At the close of the Civil War Dr. N. A. Pratt, of Georgia, formerly connected with the Niter Bureau of the Confederacy, visited Charleston with the object of starting sulphuric acid chambers. His attention was directed by Doctor Ravenel, who had already noted the presence of phosphate of lime in considerable quantity in the marl stones, or nodules, near Charleston, to samples of the rock taken from the Ashley river region. Doctor Pratt analyzed the specimens and found that the rocks contained a sufficiently high percentage of phosphate of lime to render them of merchantable value.[6] As soon as the commercial importance of the deposits became generally known other available beds were located, and considerable capital was employed in developing the industry by mining the crude rock, and exporting the product or manufacturing it into superphosphates. Later the beds of many navigable streams were found to be largely paved with the valuable substance. In 1870 the mining for this river rock began, and was developed through the introduction of dredging and grappling apparatus into an industry of equal importance with the mining of the rock on land.[7]

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[1] Phosphates of America, by Francis Wyatt, Ph. D., page 49.

[2] South Carolina, by Harry Hammond, page 47, and map.

[3] South Carolina, page 48.

[4] United States Geological Survey, "Mineral Resources of the United States," 1882, page 511.

[5] Statistics of South Carolina, by Robert Mills, page 27.

[6] United States Geological Survey, "Mineral Resources of the United States," 1882, page 511 ff.

[7] Ibid., Eighteenth Annual Report, Part V, continued, page 1236.

Table 4 shows the annual production of phosphate rock from 1867 to 1902.

TABLE 4.—*Annual production of phosphate rock: 1867 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
Total	10,682,492	Ending December 31—	
Ending May 31—		1885[1]	277,789
1867	6	1886	430,549
1868	12,262	1887	480,558
1869	31,958	1888	448,567
1870	65,241	1889	541,645
1871	74,188	1890	463,998
1872	58,760	1891	475,506
1873	79,203	1892	394,228
1874	109,340	1893	502,564
1875	122,790	1894	450,108
1876	132,478	1895	431,975
1877	163,000	1896	402,423
1878	210,322	1897	358,280
1879	199,365	1898	399,884
1880	190,763	1899	356,650
1881	266,734	1900	329,173
1882	332,077	1901	321,181
1883	378,380	1902	313,365
1884	431,779		
1885	395,403		

[1] Seven months.

From the first the industry yielded large profits, and for a period of two and a half decades was prosecuted with great energy. Beginning with a production of 6 long tons in 1867, it had increased in 1877 to 163,000 tons, and ten years later to 480,558 tons, reaching the maximum in 1889, with 541,645 tons. In 1890 the output from the Florida mines had so increased that the condition of the industry in South Carolina became serious, and by 1892 what was once at a premium became a drug. The Florida developments had not only caused an overproduction of high-grade rock, but had forced upon the market immense quantities of lower grades, which could be used without any enriching material. The reason why 75 per cent and 80 per cent rock should retain an exceptional value no longer existed, and so it sank to a common level with the poorer products.[1] The adoption by the phosphate miners of the state of desperate measures to stem the tide and shut off competition by cutting the prices, only resulted in further embarrassment, until the market price dropped below the cost of production, and it became possible for them to remain in the market only by selling at a very tangible loss.[2]

The industry received further setbacks through a royalty dispute between the state and river miners and through a cyclone, August 27, 1893, which severely injured the mining plants, especially those of the river miners at Beaufort.[3] Barring a temporary setback in 1900 to the industry in the state, due mainly to scarcity of transportation facilities and high ocean freights, a gradual recovery has continued up to the present year.[4]

Siliceous crystalline rocks.—The granites and gneisses are widely distributed and extensively quarried above the fall line. The term granite is generally applied to all these rocks by the miners of the state. The granites proper are found in abundance and their outcrops lie along three nearly parallel lines. On the most southern of these lines they show themselves among the sand hills at Graniteville on Horse creek, Aiken county, and thence at various points, in a northeasterly direction, to Columbia. Many years ago notable quarries for building materials began to be worked on this line at Graniteville and at points in Richland county.[5]

The second line of outcrop extends from the neighborhood of Harris creek, Edgefield county, across Newberry, Fairfield, and Kershaw counties to the northwestern corner of Chesterfield. Here, also, quarries of excellent granite, fine grained and easy splitting, have been found, especially in Newberry and Fairfield counties, where there are inexhaustible quantities of the best building granite. A flesh colored porphyritic granite is found in Kershaw. In Edgefield and Lancaster counties it becomes coarser and syenitic in character. The third line of outcrop stretches through Laurens, Union, and York counties. In the vicinity of Union the granite is of exceedingly fine grain and well adapted for architectural purposes, but most of it on this line is characterized by a coarse porphyried structure.[5] Granite quarrying is an important industry in the state, being exceeded in value of product only by the mining of phosphate rock.

Clay.—Clays of many varieties are found widely distributed and constitute perhaps its greatest actual and prospective resource, being susceptible of greater extension and development than any other mineral.[6] The clays were among the first in the United States to attract attention, and early in the nineteenth century, prior to 1826, a Doctor Garden carried a small shipment of South Carolina kaolin to England and manufactured it into china ware.[7] While common, or brick, clay of excellent quality is found in almost every neighborhood, the state's principal wealth in clays lies in the extensive deposits of kaolin remarkable for purity. The sedimentary kaolins are widely distributed in the Savannah river area, the Santee area, and the Edisto area, in the counties of Aiken, Lexington, Richland, and Kershaw. In this region there are extensive beds of pure white kaolin exceeding 18 feet in thickness, and affording 98 per cent of clay substance, which requires no other preparation than drying.[8]

The Savannah river area affords perhaps the most remarkable exposures of sedimentary kaolin in the United States. In some places they are practically continuous for miles. From Hamburg to Aiken extends a zone 14 miles long by 5 miles wide.[9] The beds vary from 5 to 25 feet in thickness with an overburden of cross-bedded sands, thin layers of clay, and occasional Lafayette loams and cobbles, ranging in thickness from almost nothing to more than 100 feet. The thickness of the kaolin determines the amount of overburden that can be economically removed. This overburden is degraded by laborers with pick, shovel, and cart, or with scrapes or steam shovels until a sufficient terrace of clay is bared for extraction. The kaolin is moved in lump form to the dry sheds, where, after exposure to air and light for a few weeks, it is packed in casks of 1 ton capacity and shipped to the consumer. These deposits probably represent the largest body of clay closely approximating kaolinite to be found in the United States.[1]

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[1] The Mineral Industry, 1892, Vol. I, page 368.

[2] Ibid., page 371.

[3] United States Geological Survey, "Mineral Resources of the United States," 1893, pages 704 and 705.

[4] Ibid., 1901, page 811.

[5] South Carolina, page 131.

[6] South Carolina Geological Survey, Series IV, Bulletin No. 1, Clays of South Carolina, by Earle Sloan, page 9.

[7] Statistics of South Carolina, page 28.

[8] Clays of South Carolina, pages 49 and 50.

[9] Ibid., pages 49, 50, and 81.

In the Savannah river area of the coastal plain outside of the distinctive clay zone pertaining to the Cretaceous and Eocene formations, there are beds of clay of economic importance. At North Augusta and Hamburg a large deposit of alluvial clays occurs, which is excellently adapted to the manufacture of brick and the coarser stonewares.[2] A zone of older clays occurs approximately parallel with and about 30 miles distant from the coast. These clays are often fine grained and vary in color from pale yellow to a mottled blue; they are associated in many instances with coarse sands. Their average elevation above the sea level is 60 feet. These beds are developed near Garnett, and are adapted to the manufacture of tiling, face brick, and common brick.[3]

All other minerals.—The gold belt extends from the North Carolina border, southwest across the counties of York, Lancaster, Chesterfield, Kershaw, Fairfield, Chester, Spartanburg, Greenville, Pickens, and Abbeville. Auriferous gravels are found in many localities, but chiefly in York, Union, and Spartanburg counties.[3] The first consignment of gold from the sands of this state reached the United States Mint in the latter part of 1829.[4] The first recorded discovery of gold in the state, however, antedates this by three years, and was made in the Abbeville and Spartanburg districts.[5] In 1830 and 1831 numerous workings were under way in the state, especially in Lancaster and Chesterfield counties, where, in the latter, at the Brewer mine, even at this early date, from 100 to 200 men were employed.[6]

In 1859, 20 gold mines had been opened in the talc slates of Chesterfield and Lancaster counties, and 10 in the same slates in Abbeville and Edgefield, among the latter the celebrated Dorn mine from which more than a million dollars in gold has been taken. In Spartanburg, Union, and York counties there were 19 and in Pickens and Greenville 8 others.[5]

Gold mining, except in a few localities, remains practically as it stood in 1861. One notable exception, however, is found in the Haile gold mine, located in Lancaster county, which for many years has been perhaps the most consistent producer east of the Rocky mountains. The small silver production in 1902 was also from this mine.

Limestone occurs and to some extent has been quarried in York, Spartanburg, Laurens, and Pickens counties.[7] It is used for bridge work and in crushed form for road building.[8] However, owing to the abundance of granite for these purposes, it is used chiefly for burning into lime.

A few tons of manganese ore were mined near Greenwood in 1902, the mineral in great purity and abundance having been found at the old Dorn gold mine in Edgefield county and also in Abbeville, York, Laurens, and Anderson counties.[7]

Precious stones have been found at a number of places in the state. The first garnet found in the United States was picked up in Abbeville county, about 1825.[9] It was of a greenish yellow color. Garnets have also been found in Spartanburg county; rubies in Pickens; tourmaline in York, Edgefield, Laurens, Anderson, and Oconee; beryl in Edgefield and Laurens, and zircons in Abbeville and Anderson.

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[1] Clays of South Carolina, pages 49, 50, and 81.

[2] Ibid., page 81.

[3] United States Geological Survey, "Mineral Resources of the United States," 1882, page 728.

[4] Ibid , Twentieth Annual Report, Part VI, page 111 ff.

[5] South Carolina, page 134.

[6] United States Geological Survey, Sixteenth Annual Report, Part III, page 257.

[7] South Carolina, page 137.

[8] United States Geological Survey, "Mineral Resources of the United States," 1889, page 428.

[9] Statistics of South Carolina, page 27.

SOUTH DAKOTA.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of South Dakota for 1902.

TABLE 1.—*Summary: 1902.*

	Total.	Gold and silver.	Sandstones and quartzites.	Limestones and dolomites.	All other minerals.[1]
Number of mines, quarries, and wells	77	40	12	10	15
Number of operators	77	40	12	10	15
Salaried officials, clerks, etc.:					
Number	167	148	4	1	14
Salaries	$242,421	$222,590	$2,853	$1,278	$15,700
Wage-earners:					
Average number	3,131	2,914	94	55	68
Wages	$3,374,776	$3,217,456	$69,509	$43,714	$44,097
Contract work	$8,349				$8,349
Miscellaneous expenses	$264,452	$240,112	$4,669	$366	$19,305
Cost of supplies and materials	$1,992,575	$1,936,617	$9,703	$10,455	$35,800
Value of product	$6,769,104	$6,464,258	$110,789	$86,605	$107,452

[1] Includes operators as follows: Cement, 1; graphite, 2; gypsum, 2; lithium ore, 1; mica, 3; natural gas, 3 (6 wells); precious stones, 3 (no mines).

Within the Black Hills region, which covers about 3,500 square miles, and is embraced within Custer, Lawrence, Meade, Pennington, and Fall River counties, a great diversity of minerals is found. The gold and silver mines located here have since their discovery yielded many million dollars' worth of the two metals. This region also contains vast gypsum beds, used for plaster of Paris; mica, of which large sheets are exported; petroleum and natural gas; white, red, and variegated sandstones; white and purple limestones; granite; and marble.[1]

Both lode tin and stream tin are found in the Black Hills, the ore deposits covering an area of 500 square miles, and extending in a great semicircle of 40 miles, around and northwest of Harneys peak. The production of tin in this region, however, has not yet amounted to much, though great hopes are entertained of future development. Copper, iron, manganese, lead, tungsten, graphite, and spodumene are also found in greater or less quantities in the Hills.[2]

Near Sioux Falls, in Minnehaha county, are found inexhaustible deposits of the so-called jasper, in red, pink, cherry, purple, peachblow, and gray tints. This stone has been extensively used in building and for monuments.[2]

The minerals of known occurrence in the state, but which were not produced in commercial quantities in 1902, are antimony, copper, fuller's earth, granite, iron, lead, marble, nickel, pumice, tin, tungsten, and uranium.[2]

In addition to the productive mines, quarries, and wells for which statistics are shown in Table 1, 114 operators reported gold and silver mines the work in connection with which was exclusively devoted to their care and development. During the year 1902 these operators employed 522 wage-earners and paid $581,163 in wages. The 99 salaried officers, clerks, etc., received $114,956. Miscellaneous expenses amounted to $45,210, and the cost of supplies and materials to $166,585.

Table 2 shows the value of the products of the manufacturing industries of South Dakota, based primarily on minerals mined and quarried, and also the value of all products manufactured in the state as reported to the census of 1900.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$12,231,239
Based upon products of mines or quarries:		
Clay, glass, and stone products	$293,568	
Iron and steel and their products	54,265	
Metals and metal products, other than iron and steel	2,351,342	
Miscellaneous industries	583,644	
		3,282,819
All other		8,948,420

The value of the manufactured products of the state, based primarily on minerals mined and quarried, was $3,282,819, or 26.8 per cent of the value of all the manufactured products. The total value of the product of the mines, quarries, and wells of South Dakota in 1902, plus the total value of all manufactured products in 1900, was $19,000,343, of which amount the product of mines, quarries, and wells for 1902 formed 35.6 per cent and that of manufactures for 1900, 64.4 per cent.

At the census of 1900 the manufacturing industries of South Dakota were reported as giving employment during the census year to an average number of 3,121 wage-earners and paying $1,544,409 in wages. The operators of the mines, quarries, and wells of the state reported that they employed an average of 3,131 wage-earners during 1902, and paid $3,374,776 in wages. The combined industries, therefore, employed 6,252 wage-earners and paid $4,919,185 in wages. Mining gave employment to 50.1 per cent of the wage-earners, but paid 68.6 per cent of the wages, while manufactures gave employment to 49.9 per cent of the wage-earners and paid only 31.4 per cent of the wages.

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[1] King's Handbook of the United States, page 791.

[2] Ibid., pages 792 and 793.

Table 3, compiled from reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1890 to 1902.

TABLE 3.—*Value of annual production of the principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold.[1]	Silver.[1]	Sandstones and quartzites.	Limestones and dolomites.
1890	[2]$3,200,000	[2]$129,292	$93,570	(3)
1891	3,550,000	129,293	25,000	(3)
1892	3,700,000	77,576	20,000	(3)
1893	4,006,400	181,327	30,165	$100
1894	3,299,100	76,248	9,000	3,663
1895	3,969,500	205,940	20,100	4,000
1896	4,969,800	256,727	37,077	3,126
1897	5,694,900	190,856	(3)	3,895
1898	5,699,700	186,913	9,000	26,858
1899	6,469,500	188,251	18,325	45,908
1900	6,177,600	[4]332,441	12,675	47,762
1901	6,479,500	[4]16,600	17,647	53,790
1902[5]	6,965,400	[4]180,306	110,799	86,665

[1] Estimates of the Director of the Mint; value of refined product; silver at coining value. The values given in Table 1 are the values at the mine.

[2] Includes production from North Dakota.

[3] Not reported separately.

[4] Commercial value.

[5] Census figures, except for gold and silver.

Gold.—The earliest authentic date of the finding of gold in the Black Hills is July 27, 1874, when small quantities of the precious metal were found in the bed of French creek, in Custer county, by miners accompanying the expedition of Gen. George A. Custer. From certain stories, still current, it would seem that some of the Sioux Indians and a few white men knew of the presence of gold in this region before 1874, but nothing definite is known concerning the actual facts.

A few weeks after the Custer expedition, other deposits of the precious metal were found, on December 23, 1874, about 3 miles below the present site of Custer, by a party entering the Black Hills region for settlement. Much prospecting was done in this vicinity during the winter, though little gold was found, and in the spring of 1875 the party was forced by the military to leave. The Black Hills country, then included within the Sioux reservation, was not open to settlement, and the Government made every effort to prevent prospectors from entering. This policy only intensified the desire to explore the region, and as a result of the widespread interest the Government, early in 1875, organized a special survey for the purpose of learning whether the mineral and other natural resources of the region warranted its purchase from the Indians.

The first authentic published statement of the finding of gold in the Black Hills was in a letter dated June 17, 1875, from the geologist in charge of the survey to the Commissioner of Indian Affairs at Washington, D. C., and which was first published in the Mining and Engineering Journal. The gold referred to in this letter was found June 12, 1875, in terraces or bars of quartz gravel, on the north bend of Castle creek. About a month later important discoveries in the placer deposits of Spring and Rapid creeks, northeast of Harneys peak, caused a rush in that direction, which was the first real stampede in connection with the gold excitement in the Black Hills. By this time several hundred prospectors had succeeded in gaining access to the region, and of this number more than a hundred staked out claims on Spring creek and commenced panning for gold.

The results of the survey having established the fact that the Black Hills region was of much greater value for mining purposes than it ever could be to the Indians, the Government finally purchased it from the Sioux for $4,500,000, and opened it for legal settlement February 28, 1877.

The discovery in the fall of 1875 of the rich placers of the Deadwood region, in Lawrence county, and, a few weeks later, of the rich conglomerate ores and of the great impregnated zone known as the Homestake Belt, indicated the permanent wealth of that part of the Hills and the tide of settlement turned accordingly northward from Custer. Since 1875 Lawrence county alone has far surpassed the balance of the region in the production of gold.

For ten years after gold was discovered the Black Hills had no railway facilities of any kind, but at the present time the northern part has excellent railway facilities, which fact has occasioned the opening up of many important mines. The central and southern hills are not so favored.

The gold bearing quartz veins are found chiefly in Pennington and Custer counties, in the central and southern part. Lawrence county, to the north, also has some valuable quartz veins. The ores of the impregnated zones are of great importance, one of them, the Homestake Belt, having furnished approximately three-fourths of the total output of gold in the Black Hills. The Homestake ore bearing area is an irregular belt 1½ miles long and one-half mile wide, near Lead city, forming perhaps the largest and most easily worked mass of low-grade gold ore in the world. In Lawrence county only have the ores of the impregnated zones been worked continuously for any length of time, though many claims, in Custer and Pennington counties, are said to carry as high values as the Homestake ore.

The cement ores within the Hills west and southwest of Deadwood were discovered in the early part of 1876, and in the same year the first quartz mill brought into the Hills reached Deadwood. The siliceous ores are found only in the northern part, the producing ores lying in Lawrence county.

Placer gold is found in the gravel bars of all the streams and in the various terraces lining their valleys. The richest deposits, however, are either exhausted or can no longer be worked extensively with profit because of the lack of water supply. Associated with the gold in the placers are garnets, hematite and limonite pebbles, columbite, tantalite, cassiterite, and other less noticeable minerals.[1]

The following table, compiled from reports of the Director of the Mint, shows the annual production of gold in South Dakota from 1887 to 1902:

TABLE 4.—*Annual production of gold: 1887 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	Fine ounces.[1]	YEAR.	Fine ounces.[1]
1887[2]	116,110	1895	187,187
1888[2]	125,775	1896	240,414
1889[2]	140,287	1897	275,491
1890[2]	154,800	1898	275,723
1891	171,731	1899	312,962
1892	178,987	1900	298,842
1893	193,809	1901	313,446
1894	159,594	1902	336,232

[1] Estimates of the Director of the Mint for refined product. The values given in Table 1 are the values at the mine.
[2] Includes production from North Dakota.

Silver.—Excepting the small but fairly regular amount of silver obtained from gold bullion, silver in the Black Hills is closely associated with lead.[2] Argentiferous galena ores are found in the Galena district southeast of Deadwood, in the Carbonate district northwest of Deadwood, and at Spokane. It is occasionally found elsewhere, but apparently little or no contribution to the output of the galena ores has been made from other than the three localities mentioned. The earliest developments worthy of note were made in 1881 at Galena.[3]

Silver-lead ores were found near Carbonate in 1886. Considerable lead and silver was produced by the Spokane mine during the years 1898–1900, but the mine is now idle. The character of the ore bodies in the various localities differs widely. They occur in the Algonkian in veins, in the Cambrian as shoots, and in the Carboniferous as contact deposits, the latter two graduating more or less into each other.[3]

Table 5, compiled from reports of the Director of the Mint, shows the annual production of silver from 1887 to 1902.

TABLE 5.—*Annual production of silver: 1887 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	Fine ounces.[1]	YEAR.	Fine ounces.[1]
1887[2]	417,600	1895	159,300
1888[2]	77,311	1896	229,500
1889[2]	50,000	1897	117,600
1890[2]	100,000	1898	152,300
1891	100,000	1899	145,600
1892	60,000	1900	536,200
1893	110,400	1901	78,000
1894	58,973	1902	340,200

[1] Estimates of the Director of the Mint for refined product.
[2] Includes production from North Dakota.

Sandstones and quartzites.—One of the most promising stones of the West is the pink and red quartzite quarried near Sioux Falls, in Minnehaha county. The stone is so strong as to endure a pressure of 25,000 pounds to the square inch, is grained so closely as to be almost impervious to moisture, and will take a polish almost like glass, with which it favorably compares in durability. In color the stone varies from light pink to jasper red, and is one of the few stones now quarried in the United States which are adapted equally to rough building and both interior and exterior ornamental work.[4]

Eight of the 12 quarries in the state productive in 1902 were located in Minnehaha county, while Butte, Fall River, Hanson, and Lawrence counties had only 1 each. The entire output of these quarries in 1902 was valued at $110,789, an increase over 1901 of $93,142. The value of the sandstone produced for building purposes amounted to $42,162.

Limestones and dolomites.—The 10 quarries productive in 1902 were located in Custer, Lawrence, and Meade counties, and the output was valued at $86,605, of which $54,750 was for flux for blast furnaces.

All other minerals.—The single cement plant in South Dakota was built at Yankton, Yankton county, in 1889, and produced its first Portland cement in the following year, since which time it has been in successful operation. Chalkstone of the Colorado Cretaceous and the dark, fat overlying clay are the materials used.[5]

In many parts of the Hills graphitic slates abound, and in many places the percentage of graphite is sufficiently high to arouse some interest in the economic possibilities of the deposits. Considerable prospecting has been done in the central hills, particularly near Custer, Custer county, and Rochford, Pennington county.[6]

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[1] Mineral Wealth of the Black Hills, by Cleophas C. O'Harra, page 6 ff.
[2] Ibid., page 60.
[3] Ibid., pages 60 and 61.
[4] Stones for Building and Decoration, by George P. Merrill, page 162.
[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 802.
[6] Mineral Wealth of the Black Hills, page 72.

The deposits of gypsum of the Black Hills are utilized for the manufacture of wall plaster at Speartish, Lawrence county, and Hot Springs, Fall River county.[1]

Spodumene, a source of lithium salts, has recently acquired commercial importance in the Black Hills, and considerable local activity has been shown in the development of the industry. The deposits are all found in Custer and Pennington counties. This mineral first attracted attention during the tin mining activity in 1884, at which time its occurrence was noted in several localities.[2] The most noted of these is the Etta mine, which is the only locality in which this mineral was produced in 1902.[3]

The earliest explorations for mica in the Black Hills were made in 1879, the first property upon which much work was done being the McMacken mine, near Custer. Several other mines were opened somewhat later, but most of them practically ceased operating after 1884, the work during subsequent years until 1899 being merely sufficient development work to hold claims. The mineral is found in pegmatite dikes, which occur in great abundance in the granite region of Pennington and Custer counties.[4] Many of the dikes do not contain large mica books in sufficient quantity to make them profitable producers, but all have the mica present to a greater or less extent. In 1899 the output of mica was 20,299 pounds, valued at $18,000; in 1900 the sheet mica output reached the unprecedented amount of 65,000 pounds, valued at $45,000, while the production of scrap mica was 222 tons, worth $1,554.[5] In 1902 the production of rough mica amounted to 205 tons, valued at $17,250, and 6,000 pounds of sheet mica, worth $1,200.

The natural gas found in South Dakota is associated with flows of water at various localities in Hughes and Sully counties.[6] The first well in the state was drilled at Pierre, Hughes county, in 1892, and there is no apparent diminution of gas.[7] In 1902 the 6 productive wells had an output valued at $10,280.

The rose quartz reported under the head of precious stones was mined in Custer county, where there are immense quantities of the mineral in sight.[8]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 906.

[2] Mineral Wealth of the Black Hills, page 75.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 260.

[4] Mineral Wealth of the Black Hills, pages 72 and 73.

[5] Ibid., pages 73 and 74.

[6] United States Geological Survey, "Mineral Resources of the United States," 1902, page 653.

[7] Ibid., Twenty-first Annual Report, 1899-1900, Part VI, page 316.

[8] Ibid., "Mineral Resources of the United States," 1901, page 750.

TENNESSEE.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Tennessee for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous.	Phosphate rock	Iron ore.	Marble.	Limestones and dolomites.	All other minerals[1]
Number of mines, quarries, and wells	241	84	10	22	11	81	33
Number of operators	203	73	37	13	10	44	26
Salaried officials, clerks, etc.:							
Number	773	418	115	106	38	37	59
Salaries	$664,379	$381,889	$82,125	$71,585	$37,430	$27,826	$63,524
Wage-earners:							
Average number	10,890	6,220	1,597	1,299	607	698	469
Wages	$4,864,241	$3,213,532	$493,809	$512,702	$218,764	$222,475	$202,959
Contract work	$174,196	$14,094	$157,102				$3,000
Miscellaneous expenses	$720,183	$432,029	$81,882	$111,854	$11,268	$11,162	$71,968
Cost of supplies and materials	$850,185	$390,561	$93,715	$141,540	$18,725	$101,195	$101,749
Value of products	$9,533,782	$5,399,721	$1,308,872	$1,123,527	$518,256	$482,033	$701,373

[1] Includes operators as follows: Barytes, 6; clay, 9; copper ore, 2; fluorspar, 1; gold and silver, 2; mineral pigments, crude, 1; natural gas, 1; petroleum, 1; and sandstones and quartzites, 3.

Tennessee has long been conspicuous as a mining state; for more than one hundred years its great wealth of iron ore deposits has engaged the attention of miners. The coal fields, comprising almost one-eighth of the total area of the state, are practically inexhaustible and have been worked extensively. Since the discovery of phosphate rock early in the present decade its mining has grown until the state's output of this mineral has become second only to its production of coal. The marble deposits of the state have long been famous. Their early development brought the state into prominence, and with the increasing demand for "Tennessee" marble the industry of its quarrying has grown steadily. Another important branch of mining industry is that which has developed around the valuable and extensive deposits of copper ore in the Ducktown district.

Manganese is of frequent occurrence in various parts of the state, chiefly in the eastern section in association with the iron ores. The first manganese ore mined in the United States was produced near Whitfield, Hickman county. The mine was first worked in 1837, and the output was used for coloring earthenware. The two sections from which manganese ores have been taken in commercial quantities are the vicinity of Sweetwater, Monroe county and in Unicoi county.[1]

Lead and zinc ores occur at numerous points in the eastern and middle parts of Tennessee, and a half century or more ago in the Valley range west of the line of Red Knobs lead mining gained considerable headway. The industry has not been revived, although deposits of galena occur that seemingly would warrant commercial exploitation. Interesting features of this locality are the old and quite extensive "diggins," about which the oldest inhabitants and the Indians before them knew nothing.[2] It has been surmised that these excavations were made in a search for galena. Whether the object was to secure galena or other minerals, these workings point unerringly to an era of mining activity which antedates both history and tradition, and most probably was cotemporaneous with the still more extensive and systematic operations in the mountains of North Carolina, and with prehistoric copper mining in the Lake Superior region. The deposits of zinc ore, especially those in the vicinity of Knoxville, have been worked in a desultory way for many years, and considerable quantities of ore have been calcined and shipped to eastern smelters.[3]

Millstones of excellent quality have been made from some of the rock formations. Those made from chert were in great demand at one time and were regarded as being equal to the French buhrstone.[4]

Cement has been manufactured at numerous points from the outcroppings of the limestone, and asphaltum, granite, gypsum, and roofing slate are known to occur in greater or less quantities.

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[1] United States Geological Survey, Sixteenth Annual Report, 1894–95, Part III, pages 423 and 424.

[2] Geology of Tennessee, by James M. Safford, A. M., Ph. D., pages 484 and 485.

[3] United States Geological Survey, "Mineral Resources of the United States," 1882, page 367 ff.

[4] Geology of Tennessee, page 511.

The following minerals are known to occur in the state, but were not produced in commercial quantities in 1902: Asphaltum, cement, granite, gypsum, lead ore, manganese ore, millstones, slate, and zinc ore.

A total of $22,940 was expended in the state in development work during 1902, but no product was realized. The minerals receiving attention in this way were natural gas, petroleum, and copper ore.

Table 2 shows the relative importance of the manufacturing industries closely allied to or based upon the mining industry, using as their raw material the products of mines and quarries.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product	
All manufactures		$108,144,565
Based upon products of mines or quarries.		
Chemicals and allied products	$1,649,078	
Clay, glass, and stone products	2,050,386	
Iron and steel and their products	9,848,440	
Metals and metal products, other than iron and steel	1,308,700	
Miscellaneous industries	3,703,078	
		18,565,682
All other		89,578,883

The total value of the products of the manufacturing industries based on mining was $18,565,682 or 17.2 per cent of the total value of the product of all manufacturing industries in 1900. During the same year there were employed in all branches of manufactures 50,504 wage-earners, who were paid $16,647,638 in wages. In 1902 the mines and quarries gave employment to 10,890 wage-earners, who received $4,864,241 in wages. By combining the figures of these two branches of industry it is disclosed that 82.3 per cent of the wage-earners receiving 77.4 per cent of the wages were employed in manufacturing, while 17.7 per cent of the wage-earners receiving 22.6 per cent of the wages were employed in mining.

The following table shows the value of the annual production of the principal minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey. "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Phosphate rock.	Iron ore.	Marble.	Limestones and dolomites.
1890	$2,395,746	(1)	(2)	$419,467	$73,028
1891	2,668,138	(1)	(2)	400,000	70,000
1892	2,355,441	(1)	$505,359	350,000	20,000
1893	2,048,449	(1)	392,771	150,000	126,099
1894	2,119,481	$67,158	288,005	231,796	158,664
1895	2,349,032	82,160	447,852	362,277	156,898
1896	2,291,295	57,370	432,952	381,373	157,176
1897	2,329,534	193,115	479,485	441,964	113,774
1898	2,337,512	498,892	481,192	316,814	182,402
1899	2,940,644	1,192,916	694,372	[3]384,705	208,097
1900	4,003,082	1,328,707	669,087	424,054	238,506
1901	4,067,389	1,192,090	912,849	494,637	330,927
1902[4]	5,399,721	1,308,872	1,123,527	518,256	482,033

[1] No production.
[2] Value not reported.
[3] Includes production from North Carolina.
[4] Census figures.

Coal, bituminous.—The most valuable contribution to the mineral wealth of the state are the coal fields, comprising more than 5,000 square miles and traversing the state in a northeast and southwest direction.[1] The belt in which these coal measures occur is coextensive with the Cumberland table-land and varies in width from 71 miles at the northern boundary to 50 miles at the Georgia and Alabama state line.[2] In this belt the industry of coal mining has been developing since long before the Civil War, during which its growth was temporarily interrupted.[3] Practically all the mining of these earlier years was on a petty scale, and outside of Nashville and Memphis very little coal was used, except for blacksmithing purposes.[3] The industry did not reach a scale of any considerable importance until some fifteen years after the war,[3] but it has developed steadily since. In 1892 its progress was seriously interfered with by strikes. Since 1893 production has increased rapidly, the output for 1902 being 50 per cent greater than that for 1897, and more than double the production at the beginning of the decade.[4] Nineteen counties of the state are embraced wholly or in part within the coal belt, and the range of the industry has expanded until coal is produced in practically all of these counties. In Campbell county is a part of the famous Jellico steam-coal field. The Sewanee vein, one of the most important, is extensively worked in Grundy county. Much high-grade coke is made from this product.

Other counties in which extensive coking establishments are under way are Claiborne, Hamilton, Marion, Rhea, and Roane.[5] Eighty-eight per cent of the yield in 1902 was from the following counties: Anderson, Campbell, Claiborne, Cumberland, Grundy, Marion, Morgan, Rhea, and Scott. The annual production of the Tennessee mines from 1870 to 1902 is shown in Table 4.

TABLE 4.—*Annual production of coal, bituminous: 1870 to 1902.*

[United States Geological Survey. "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.
1870	149,428	1887	1,900,000
1871	180,000	1888	1,967,297
1872	224,000	1889	1,925,689
1873	350,000	1890	2,169,585
1874	350,000	1891	2,413,678
1875	360,000	1892	2,092,064
1876	550,000	1893	1,902,258
1877	450,000	1894	2,180,879
1878	375,000	1895	2,535,644
1879	450,000	1896	2,663,106
1880	644,042	1897	2,888,849
1881	750,000	1898	3,022,896
1882	850,000	1899	3,330,659
1883	1,000,000	1900	3,509,562
1884	1,200,000	1901	3,633,290
1885	1,440,957	1902	4,382,968
1886	1,714,290		

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[1] Geology of Tennessee, page 366.

[2] United States Geological Survey, Sixteenth Annual Report, Part IV, page 188.

[3] Ibid., "Mineral Resources of the United States," 1885, page 64.

[4] The Production of Coal in 1902, by Edward W. Parker, page 183.

[5] United States Geological Survey, Sixteenth Annual Report, page 188.

Phosphate rock.—The phosphate rock mined in this state has been classified into three groups or varieties, according to color. These are blue rock, which occurs mainly in Hickman county; white rock, as typified by the deposits occurring in Perry county; and brown rock, deposits of which are confined principally to Maury county.[1] Rocks containing varying percentages of phosphate occur in several other counties in the phosphate rock region, which extends from the vicinity of Nashville, south to the Tennessee river.

The discovery and exploitation of the deposits of this valuable mineral in the state constitutes, in the main, a repetition of the events attending the discovery of phosphatic rock in both South Carolina and Florida. In all these cases the valuable phosphatic contents of the rock became known by accident. The existence of the rocks was a matter of common knowledge, and their peculiarities, at least in the case of South Carolina and Tennessee, had been the subject of extended study and investigation by geologists. A remarkably accurate description of the physical characteristics of the phosphate deposits of Tennessee was given by Doctor Safford, in 1869, in his Geology of Tennessee. Their chemical nature and great commercial value, however, remained a secret for a quarter of a century longer.

Certain kinds of phosphate rock in Tennessee have been used for many years in building operations requiring stone. An object of interest to visitors to the fields at present is a stone house made almost entirely of phosphate rock many years ago by a religious recluse.[2]

The discovery of the deposits, the development of which marked the beginning of phosphate mining in the state, occurred in October, 1893. During that year Messrs. L. Bates and R. Childs had been prospecting for coal in this section and a Mr. Harder, while fishing in Swan creek in Lewis county, found some peculiar looking rocks, which he sent to these coal prospectors for examination. Thinking the rocks indicated coal these prospectors shipped them to Prof. J. C. Wharton, an analytical chemist of Nashville. Upon examining them the chemist found one of the specimens to be a high grade of phosphate rock.[3] When the discovery became known the scenes enacted in South Carolina and Florida were repeated. Prospectors and speculators were early on the ground, and other discoveries quickly followed in all directions. By July, 1894,[3] several companies had been organized, extensive tracts of land had been purchased or leased, and the industry of phosphate mining was well under way. In the latter part of this year the phosphate rock of Tennessee first became a distinct factor in the market. About 45,000 tons were mined and shipped between July, 1894, and July, 1895. For two years after the beginning of the industry all the phosphate rock that left the state was mined in Hickman county.[4] In December, 1895, the Hon. S. Q. Weatherby, while passing along a road near Mt. Pleasant, in Maury county, observed in the deep cuts a thinly laminated rock that to him suggested zinc ore. Actuated mainly by curiosity, and with no thought of making any valuable discovery, he broke a piece to study its structure, and found that instead of confirming his impression as to zinc ore it presented a granulated appearance characteristic of the phosphate rock of Lewis and Hickman counties. Samples were secured and sent to Mr. Lucius P. Brown, an analytical chemist of Nashville, for examination, and they were found to contain phosphate of lime ranging in percentages from 75.2 to 78.1. For some months this new discovery was not allowed to become known beyond a chosen few, and in the meantime options were taken on much of the land containing the phosphates. Mining operations were begun within the town limits of Mt. Pleasant in July, 1896, and the first shipment was made on the 20th of that month. On this public disclosure there was excitement in all the surrounding neighborhood, pervading all classes.[5] The industry was prosecuted on a commercial scale from the start, and grew rapidly. Table 5 shows the monthly shipments of rock from Mt. Pleasant during the first thirteen months.

TABLE 5.—*Monthly shipments of phosphate rock from Mt. Pleasant district: 1896 and 1897.*

[United States Geological Survey, "Mineral Resources of the United States."]

DATE.	Pounds.	DATE.	Pounds.
1896.		1897.	
July (11 days)	781,737	January	16,518,412
August	5,783,965	February	15,244,650
September	5,746,782	March	15,061,300
October	5,616,589	April	18,514,460
November	10,772,896	May	22,323,520
December	15,302,292	June	12,379,000
		July	20,142,900

By the latter part of 1896 the center of activity had moved from Hickman to Maury county, and it has remained there since. In 1898 Tennessee contributed 22 per cent of the total production of phosphate in the United States, and 12.4 per cent of the aggregate output of the world.[6] In 1899 the state exceeded South Carolina in production, and has been second to Florida since.

The outlook for the industry in the state is promising. Conditions are favorable for the economical operation of fertilizer factories. The shales with which the deposits of phosphate are interstratified are rich in sulphur, from which can be manufactured the sulphuric acid necessary in the treatment of phosphate rock. Thus the two essential raw materials in the manufacture of fertilizers are delivered, as it were, at the very doors of the factories free of freight charges.[1]

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[1] United States Geological Survey, Twentieth Annual Report, Part VI, continued, page 633.

[2] Bureau of Labor Statistics and Mines, of Tennessee, Fifth Annual Report, page 269.

[3] Ibid., page 270.

[4] Bureau of Labor Statistics and Mines, of Tennessee, Eighth Annual Report, page 195.

[5] Ibid., pages 203 and 204.

[6] Ibid., Ninth Annual Report, page 101.

Table 6 shows the annual production of phosphate rock from 1894 to 1902.

TABLE 6.—*Annual production of phosphate rock: 1894 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1894	19,188	1899	430,192
1895	38,515	1900	454,491
1896	26,157	1901	409,653
1897	128,723	1902	390,799
1898	308,107		

Iron ore.—The iron ore deposits of Tennessee are comprised within four clearly defined belts extending across the state. The central, or Cumberland, belt embraces an area of about 5,000 square miles,[2] and is coextensive with the coal fields. The ore found in this belt is red hematite. In a relative sense this belt is of minor importance.[3] The other three belts are producers, and the bulk of the state's great wealth in iron ores lies within their limits. The eastern belt extends along the Smoky mountains. Limonite, hematite, and magnetic ores are found in this region. They do not occur in regularly stratified beds nor in true veins, but in masses of varying sizes, ranging from small lumps to blocks of 10 and 15 feet in diameter. Ore recently discovered in this district is highly impregnated with magnetic properties, and exerts a marked influence over the needle of a compass 10 feet away. There are indications that this ore exists in large quantities.[4] The Dyestone belt is parallel with the base of the Cumberland table-land.[5] The chief ore of this belt is a stratified red iron rock of highly fossiliferous character. The belt is remarkable for the extent and richness of its ore deposits, from which has been taken the bulk of the state's production. The ore averages 60 per cent metallic iron.[4] The western belt traverses the state from north to south along the dividing line between middle and west Tennessee. It is 50 miles in width, and embraces an area of more than 5,000 square miles. The ore throughout this belt averages about one-third metallic iron.[5]

The iron ores of Tennessee have long been celebrated. The first settlers in the state began the manufacture of iron soon after the close of the War of the Revolution.[6] Three-quarters of a century ago iron in the form of blooms was manufactured and shipped to Pittsburg.[7] In 1850 Tennessee stood fourth among the states in the production of iron ore,[8] and except during the Civil War the industry has grown steadily since that time. In the manufacture of car wheels and the best grades of bar iron no ore is superior to the ore of Tennessee.[9] In Table 7 is shown the annual production of iron ore in the state from 1890 to 1902.

TABLE 7.—*Annual production of iron ore: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1890	465,695	1897	604,497
1891	543,923	1898	623,227
1892	406,578	1899	682,046
1893	372,996	1900	594,171
1894	292,831	1901	789,494
1895	519,796	1902	871,542
1896	535,484		

Marble.—The marbles of Tennessee, forming one of the state's principal mineral resources, are widely distributed. They have been quarried in the eastern, middle, and western sections of the state.[10] The chief deposits, however, are comprised within an almost unbroken zone or belt 20 miles in width and more than 100 miles in length, situated in eastern Tennessee, with Knox county as its center.[11] Within this range the supply of marble is practically inexhaustible. There are many kinds suitable for the various uses to which marble has been put. In color almost every tint and shade between white and black is found in a great variety of combination. There is no record of the earliest marble working in the state except that chiseled into the first products of the industry. These old tombstones, still sharp and clear in outline, scattered through the churchyards of the region, and especially those around the First Presbyterian church in Knoxville, serve the double purpose of carrying the date of their manufacture back into the morning of the nineteenth century and of affording the most convincing proof of the enduring qualities of the marble from which they were cut. Marble quarrying along systematic lines dates from April, 1838, the first quarry being opened at Rogersville, the seat of Hawkins county.[12] Orville Rice, a Yankee clock peddler,[13] was elected president, and the company was organized for the purpose of sawing marble and establishing a marble factory in the vicinity of Rogersville.[14] This quarry was located on the line of the stage road, and soon after the quarrying operations were started Mr. Rice began the erection of a large brick tavern, the interior of which he richly and profusely ornamented with marble mantels, shelves, steps, and wainscoting. The house was known as "Marble Hall," and is still standing, being used at present as a residence.[1] A block of the light mottled strawberry variety was sent to the builders of the Washington Monument; it was inscribed "Hawkins County Block." Another block, sent by authority of the legislature, was called the "Tennessee State Block."[2] These attracted the attention of the building committee of the Capitol at Washington, D. C., and although they had specimens from all the then known marble deposits of the country, they decided in favor of the East Tennessee marble.[2]

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[1] Bureau of Labor Statistics and Mines, of Tennessee, Fourth Annual Report, page 119.

[2] Ibid., Second Annual Report, page 308.

[3] The Universal Cyclopedia, Vol. II, page 350.

[4] Bureau of Labor Statistics and Mines, of Tennessee, Second Annual Report, page 309.

[5] The Universal Cyclopedia, Vol. II, page 350, and Bureau of Labor Statistics and Mines, of Tennessee, Second Annual Report, page 308.

[6] Iron in All Ages, by James M. Swank, page 288.

[7] The United States Geological Survey, "Mineral Resources of the United States," 1883–84, page 277.

[8] Bureau of Labor Statistics and Mines, of Tennessee, Seventh Annual Report, page 51.

[9] United States Geological Survey, "Mineral Resources of the United States," 1883–84, page 279.

[10] Geology of Tennessee, page 506 ff.

[11] Bureau of Labor Statistics and Mines, of Tennessee, Fifth Annual Report, page 248.

[12] Ibid., page 244.

[13] Ibid., page 245.

[14] Geology of Tennessee, page 508.

Following this decision an extensive quarry was opened by the Government at a point near Rogersville where the Holston river intersects the marble range, and from here many thousand cubic feet were taken. It was used in constructing the balustrades and columns of the stairs leading up to the House and Senate galleries, the walls of the marble room, and other parts of the building. About one-half of the ornamental material in the Capitol is of Tennessee marble.[3] This unequaled means of advertising at once brought the state into national prominence as a marble producer. In 1902 Tennessee ranked second in the production of marble for interior decoration and fourth in the total value of marble products.

Limestones and dolomites.—Most of the product of the limestone and dolomite quarries is burned into lime or is used as flux in iron furnaces. The building limestones of the state have only a local reputation, are generally not of high grade, and are quarried to only a limited extent. Almost one-half of the output of building stone of this character during 1902 was from Davidson county. A compact, finely fossiliferous, light pink spotted limestone occurs near Nashville. Near Chattanooga a magnesian limestone of bluish black color is quarried for local use. This stone is said to be durable. Other localities where limestones occur and have been quarried to some extent for building purposes are near Columbia, and at Carters Creek, in Maury county, and at Morristown and Springfield. A fine grained, compact, and light colored oolitic stone, which cuts to a sharp, smooth edge and seems to be a most excellent stone, occurs near Sherwood station.[4]

All other minerals.—Barytes occurs in numerous places in the state. Since it is frequently the matrix of lead ore, its occurrence is notable in the lead regions. There are important deposits in Greene county and at Haysboro, in the vicinity of Nashville.[5]

Except in the use of common clay for brick, very little mining of this mineral is carried on. A large bed of what is claimed to be kaolin or porcelain clay occurs in the state,[6] but there was no production from it in 1902. The production of clay in 1902 consisted of pipe, ball, fire, and stoneware clay, and was mined to some extent in Carroll and Hardeman counties, but chiefly in Henry county.

While deposits of copper ore occur at numerous places in the mountain region, the great deposits are in the Ducktown district of Polk county, in the extreme southeastern portion of the state. These ore deposits are not true fissure veins; they are great lenticular masses of ore and gangue material lying conformably between strata of country rock. These masses or veins occur generally in long ranges or belts, one succeeding another longitudinally in approximately the same line, and their feather edges not infrequently overlap though thrown apart by intervening rock.[7] The discovery of copper in Polk county followed the discovery of gold made some years previously on Coqua creek. It was in the search for the latter metal that one of the gold hunters, Mr. Semmons, in 1843, found crystals of red copper ore while panning the gravels for gold in a branch at a point where the Hiwassee copper mine was later opened. Further investigation was carried on by a Mr. Grout and several rich specimens of native copper were found. In 1847 a German miner named Weber secured possession of the property and made the first shipment of copper ore from the district. This consisted of 90 casks and was sent to the Revere Smelting Works, near Boston. Before he had learned the real value of his shipment the miner left and operations ceased. In 1849 Mr. John Caldwell reached the district in a search for copper ore, and to him, perhaps, more than to any other is due the credit for the development and exploitation of these valuable and extensive deposits. The first mine opened in the district was the Hiwassee in August, 1850. Next came the Cocheco in October of the same year, and one year later the Tennessee. In 1852 two other mines were opened. In 1853 this number was increased by 6 others with 3 more in 1854. When the almost insuperable obstacles in the way of the transportation of machinery through the wild mountainous country to the district and the hauling of the product from it are considered, this rapid development is all the more remarkable and indicates plainly the richness and extent of the deposits. By the end of September of the following year, 1855, 14,291 tons of ore, worth more than a million dollars, had been shipped from the district. The Ducktown district continued to develop; to the industry of mining was added that of smelting, and later rolling mills were constructed. Mining operations were interrupted during the greater part of the Civil War period. As a result of this prolonged suspension the mining properties suffered greatly, skilled laborers were dispersed, and, on the whole, conditions in 1865 were altogether unfavorable for a resumption of activity. However, the excellent quality of the Ducktown copper, and the demand for it, furnished a very potent stimulus, and soon operations were under way on an even wider scale than before. The copper industry was one of the first to recover from the effects of this period of great industrial depression, and has continued to be an important factor in the state's mineral development since.[1]

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[1] Bureau of Labor Statistics and Mines, of Tennessee, Fifth Annual Report, page 245.

[2] Geology of Tennessee, page 508.

[3] Ibid., page 509.

[4] Stones for Building and Decoration, by George P. Merrill, page 322.

[5] Geology of Tennessee, pages 224, 283, and 503.

[6] United States Geological Survey, "Mineral Resources of the United States," 1893, page 660.

[7] Geology of Tennessee, page 477.

Fluorspar occurs in numerous places in the state and especially in Smith, Trousdale, and Wilson counties. Some of the deposits are of commercial importance. Fluorspar mining is new in the state, being a development of the last one or two years.[2]

The only section of the state in which gold has been found in any important quantity is the southeastern part between the French Broad river and the Georgia line. Most of the mining operations have been confined to Coqua creek and vicinity, a strip of country about 10 miles long by 2 or 3 miles wide. The first discovery of gold in the state occurred in this region in 1831. Considerable placer mining was done at this time and some gold has been mined each year since, but the industry is of minor importance.[3]

The only production of crude mineral pigments reported for 1902 was a small quantity from James county.

The beginning of the production of natural gas in the state is of quite recent date, and the only report in 1902 was of a small amount in Franklin county.

The first successful borings for petroleum in the state were probably those in the southern part of Overton county in 1866.[4] The industry at present is of minor importance, the total production reported in 1902 being a small quantity from Fentress county.

The workable sandstones of the state are not widely distributed. A fine grained light pink and coarse buff variety occurs at Sewanee and a coarse gray variety at Parksville.[5]

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[1] Geology of Tennessee, page 469 ff.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 890.

[3] Geology of Tennessee, page 489 ff.

[4] Ibid., pages 350 and 499.

[5] Stones for Building and Decoration, page 165.

TEXAS.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of Texas for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Petroleum.	Coal, bituminous.	Quicksilver.	Limestones and dolomites.	Sandstones and quartzites.	Siliceous crystalline rocks.	Natural gas.	All other minerals.[1]
Number of mines, quarries, and wells	1,067	955	26	5	35	13	8	14	11
Number of operators	308	211	24	3	31	13	8	5	10
Salaried officials, clerks, etc.									
Number	1,210	999	91	19	50	11	8	1	31
Salaries	$664,802	$441,129	$90,086	$19,976	$21,383	$8,689	$8,400	$2,000	$70,229
Wage-earners:									
Average number	3,853	723	1,979	233	275	191	56	....	396
Wages	$2,261,639	$699,259	$991,391	$87,414	$124,272	$100,369	$41,184	....	$217,770
Contract work	$1,387,706	$1,363,163	$98	$235	.....	.....	.....	$18,812	$5,218
Miscellaneous expenses	$923,769	$713,176	$102,237	$6,306	$8,458	$7,644	$2,304	$2,612	$81,033
Cost of supplies and materials	$1,051,457	$675,987	$99,127	$71,473	$31,522	$21,261	$6,035	$125	$142,317
Value of product	$6,981,532	$4,174,731	$1,477,245	$254,350	$228,662	$165,565	$60,000	$11,963	$606,028

[1] Includes operators as follows: Asphaltum and bituminous rock, 1; cement, 2; clay, 3; gold and silver, 1; gypsum, 2; iron ore, 1 (2 mines).

As shown in the above table, the total output of the mineral industry in Texas during 1902 was valued at $6,981,532; of this amount the product of petroleum wells, valued at $4,174,731, formed 59.8 per cent, and that of coal mining, with a valuation of $1,477,245, constituted 21.2 per cent. Petroleum and bituminous coal together represented more than four-fifths of the total value of the mineral production in the state.

The gypsum reported in Texas was about one-tenth that of the entire United States production and ranked third in importance among the minerals of the state. There were but two establishments reporting, and therefore the separate statistics for this industry are not published.

Quicksilver ranked fourth in value among the minerals of the state, the value of the production amounting to 16.4 per cent of the total for the United States. Following in the order of their importance may be mentioned the production of cement, limestones and dolomites, sandstones and quartzites, gold and silver, siliceous crystalline rocks, natural gas, iron ore, clay, and asphaltum and bituminous rocks.

A large number of minerals, for which no commercial production was reported during 1900, are known to occur in Texas. Among these may be mentioned the following: Antimony, asbestos, bismuth, copper, feldspar, garnet, manganese, marble, molybdenum, slate, and talc. Agate, amethyst, opal, and tourmaline have also been found in the state.

Development work was carried on during the year at 71 mines, quarries, and wells by 51 operators, their attention being almost entirely directed to petroleum and gas wells, coal mines, and sulphur and pyrite mines. These operators paid $37,209 to their 36 salaried officials, clerks, etc. They also gave employment to 48 wage-earners and paid $46,766 in wages. The amount expended for contract work was $245,542; the miscellaneous expenses were $29,912; and the cost of supplies and materials was $51,679.

The relative importance of manufacturing industries closely allied to or based upon the mineral industry, and using as their raw material the products of the mines and quarries, is shown in Table 2 by value of products.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$119,414,982
Based upon products of mines or quarries:		
Chemicals and allied products	$657,827	
Clay, glass, and stone products	2,490,360	
Iron and steel and their products	2,969,000	
Metals and metal products, other than iron and steel	8,306,672	
Miscellaneous industries	5,199,974	
		19,623,833
All other		99,791,149

Table 2 shows that the value of the manufactured products bearing intimate relation to the mining industry amounted to $19,623,833, or 16.4 per cent of the total manufactured product of the state in the year 1900. During this year there were employed in the manufacturing industries in Texas 48,153 wage-earners, who received $20,552,355 in wages. In 1902 the operators of the productive mines, quarries, and wells of the state reported the employment of 3,853 wage-earners, to whom was paid the sum of $2,261,639. Of the combined figures it is shown that 92.6 per cent of the total wage-earners were employed by manufacturing establishments in 1900 and that they received 90.1 per cent of the wages, while but 7.4 per cent of the entire number of wage-earners were, in 1902, engaged in the mineral industry, and were paid 9.9 per cent of the total wages.

The following table compiled from the reports of the United States Geological Survey, shows the value of the principal minerals produced in Texas from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Petroleum.	Coal, bituminous.	Limestones and dolomites.	Sandstones and quartzites.	Siliceous crystalline rocks.
1890	$227	$465,900	$217,835	$14,651	$22,550
1891	227	412,300	175,000	6,000	75,000
1892	225	769,333	180,000	18,000	50,000
1893	210	688,407	28,100	77,655	48,991
1894	300	976,458	41,526	62,350	(¹)
1895	250	913,138	62,526	97,336	(¹)
1896	1,050	896,251	77,252	36,000	(¹)
1897	37,662	972,323	37,258	30,030	3,500
1898	277,135	1,130,763	70,321	77,190	4,687
1899	473,443	1,331,895	109,025	35,738	51,905
1900	871,996	1,581,914	121,728	37,038	76,069
1901	1,247,351	1,907,024	274,658	111,568	27,005
1902²	4,173,731	1,477,245	228,662	165,665	60,083

¹ Not reported separately.
² Census figures.

Petroleum.—The presence of oil in tar springs, oil seeps, etc., in Texas had been known for many years, but the first record of the discovery of petroleum in quantities sufficient for use seems to have been about 1867, when it was found at a point 15 miles southeast of Nacogdoches.[1] But little attention was paid to these petroleum deposits until 1883. During the period from 1887 to 1890, 90 wells were drilled in the vicinity of Nacogdoches. Statistics of production first appeared in 1889, when 48 barrels were reported, with a valuation of $340.

About 1894 oil was accidentally found at Corsicana, during the sinking of an artesian well.[2] A company was formed and other wells were sunk, oil being discovered in 1898 at a depth of 1,040 feet. The drilling in this locality is entirely through a hard clay, and the oil obtained, resembling the Kansas product, is better than the Ohio oil, but not as good as the Pennsylvania. The Corsicana product has been used exclusively for fuel and in the manufacture of illuminating gas in Dallas, Houston, and Austin.[3]

The unexpected outburst of a 6-inch gusher in 1901 near Beaumont, in Jefferson county, was the sensation of the petroleum industry in the United States. Beginning on January 10, in nine days a stream 160 feet in height emptied out an estimated quantity of 500,000 barrels of oil before being capped. As a result of this wonderful find many companies were formed, drilling commenced without delay, and in less than six months there were 211 operators in that county. The elevation known as Spindle Top embraces about 125 acres, and is in its highest part 40 feet above sea level; the surrounding plain slopes southward 18 miles to the Gulf of Mexico. This was the scene of most active operations, and land was divided into small lots selling for fabulous prices.[4]

At Sour Lake, in Hardin county, a slight development was reported in 1893, but it was not until 1901 that any considerable results were obtained. A gushing well, flowing an 8-inch stream, was drilled early in 1902, and during the year a number of wells have been completed and the value of the field has been fully established.

At the Saratoga well, 12 miles northwest of Sour Lake, successful development work in 1902 was reported. In Bexar county a small quantity of heavy oil was produced and supplied a local demand. Work in the Nacogdoches district, in which there were the first indications of petroleum in the state, has been practically abandoned, and no production was reported for 1902.[5]

Table 4, compiled from the reports of the United States Geological Survey, presents the annual production of petroleum in the state of Texas from the beginning of the industry to the present time.

TABLE 4.—*Annual production of petroleum: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1889	48	1896	1,450
1890	54	1897	65,975
1891	54	1898	546,070
1892	45	1899	669,013
1893	50	1900	836,039
1894	60	1901	4,393,658
1895	50	1902	18,083,658

This table indicates the wonderful development of the Texas petroleum fields since 1900. During 1902 the volume of production was second only to that of Ohio. In a number of counties, not actual producers, petroleum has been located in greater or less quantity. Development work has been carried on to a very great extent, over $400,000 having been expended during 1902 in nonproductive operations in connection with the petroleum industry.

Coal, bituminous.—Coal was known to exist in Texas as early as 1836, and in 1840 a company was incorporated to mine this fuel. A further investigation in 1846 of the Trinity river district, 200 miles above Galveston, resulted in the finding of coal in more extensive measures than was anticipated, both anthracite and a semibituminous coal resembling cannel coal, being discovered.[1] In 1859 the first geological report of Texas contained an estimate as to the area of the coal fields in the state, and in 1866 the coal seams at Belknap were mentioned as well as a bed of coal about 6 miles north of that place.[2]

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[1] Bulletin of the University of Texas, No. 5, July, 1901, pages 1 and 2.

[2] United States Geological Survey, Nineteenth Annual Report, 1897, Part VI, page 104.

[3] The Mineral Industry, 1897, Vol. VI, page 515.

[4] United States Geological Survey, "Mineral Resources of the United States," 1901, pages 565 to 567.

[5] Ibid., 1902, pages 571 and 572.

Coal production in Texas during 1902 may be said to have centered in Erath county, where the amount reported exceeded that of all the other counties in the state. Webb county, in the southern part of the state, was second in importance, and Wise county in the northern part of the state, ranked third. Maverick county, on the Rio Grande river, and adjoining Webb county, was fourth, and Parker county, between Erath and Wise counties, ranked fifth, and a small production was also reported in Eastland county. These were all bituminous localities, and their total production was valued at over $1,300,000 during 1902.

The secondary coal fields of Texas, for which production of lignite was reported during 1902, were found principally in the following counties, ranking in the order named: Milam, Bastrop, Medina, Robertson, and Wood. Several other minor productive localities were reported.

Coal measures are found in Texas in three districts. The northern or bituminous field is the southern extremity of the Western coal basin of the United States; the semibituminous seam along the Rio Grande is second in importance; and larger than either in extent and thickness, but least in value of production, is the lignite field, lying in the central part of the state, and including over fifty counties in whole or in part.[3]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in Texas from 1883 to 1902:

Table 5.—*Annual production of coal, bituminous: 1883 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1883	100,000	1890	184,440	1897	639,341
1884	100,000	1891	172,100	1898	686,734
1885	138,928	1892	245,690	1899	883,832
1886	100,000	1893	302,206	1900	968,373
1887	75,000	1894	420,848	1901	1,107,953
1888	90,000	1895	484,959	1902	901,912
1889	128,216	1896	544,015		

As shown in the above table there was a uniformly increasing production of coal in Texas from 1891, until within the last year, when the vast exploitation of petroleum wells exerted a depressing effect on the industry. The reports for 1902 showed a decrease in production of 206,041 short tons, with a valuation of $429,779 less than that reported for the previous year.

Quicksilver.—The existence of cinnabar, in the neighborhood of California Hill, was known to the Comanche Indians, as evidenced by the use in rude paintings and hieroglyphics found on the limestone bluffs in this locality of a vermilion pigment prepared from this ore. With this exception no knowledge of these cinnabar deposits reached civilization until about 1887, when rumors of their existence were reported, but it was not until 1894 that their location was actually discovered. During 1896 and 1897 considerable prospecting was done, and in 1900 the first furnace was erected and ore treatment was begun.[4]

The cinnabar deposits occur in massive limestone, in siliceous shales, and in a white, earthy, clay-like rock; the ore is generally soft and friable, differing in this respect from the cinnabar of the New Almaden mine in California, which is found in hard masses or in veinlets.[5] The mercury occurs, not only as cinnabar and as yellow sulphide, but it also is present in the native state in several localities. Cinnabar, however, is the principal mineral.

The mining operations have been most crude in method; often the material mined has been carried to the surface on the backs of the Mexican miners. A scarcity of water and fuel has delayed the complete development of these quicksilver deposits, but the recent discovery of asphaltum and coal and the possible occurrence of petroleum may increase the general interest in this locality.

During 1900 the first production of quicksilver in Texas was reported, amounting to 750 flasks; in 1901 this amount was increased to 2,932 flasks, valued at $132,438, while in 1902 there were reported 5,319 flasks of quicksilver and 1,300 short tons of unrefined cinnabar, with a total valuation of $254,350. This production is entirely in Brewster county in the vicinity of Terlingua.

Limestones and dolomites.—Valuable limestone deposits are scattered throughout a large portion of the state; a production was reported in 25 counties during 1902. The principal productive locality is in the vicinity of Austin, Travis county, where a light colored, fine grained limestone is quarried. El Paso county is second in value of product and Williamson county, adjoining Travis on the north, is third. Much of the production is a compact, fine grained cretaceous stone of excellent quality, a part of which is crystalline, and when highly polished is suitable for interior decorative work. A dark mottled variety of stone also occurs in some parts of the state.[6]

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[1] Statistics of Coal, by Richard C. Taylor, pages 223 and 224.

[2] The Coal Regions of America, by James Macfarland, Ph. D., pages 501 and 502.

[3] United States Geological Survey, "Mineral Resources of the United States," 1888, pages 368 and 369.

[4] Bulletin of the University of Texas, No. 15, 1902, pages 11 and 12.

[5] Transactions of the American Institute of Mining Engineers, Vol. XXV, pages 72 and 73.

[6] Stones for Building and Decoration, by George P. Merrill, page 322.

There was quarried in Texas during 1902 limestone and dolomites to the value of $228,662.

Sandstones and quartzites.—The principal sandstone quarrying operations in Texas during 1902 were in Brazos county, where a carboniferous stone of a gray color is obtained.[1] Ward county, in the extreme western part of the state, was the second locality in importance, with Burnet and Fayette counties, respectively, third and fourth in rank.

Before 1901 the sandstone quarrying in Texas was of but little consequence, but during that year and 1902 the industry grew until it has taken an important place among the minerals of the state. The production of 1902 was valued at $165,565.

Siliceous crystalline rocks.—The siliceous crystalline rocks quarried in the state during 1902 were obtained in Llano and Burnet counties, in the central part of the state, near the towns of Llano, Kingsland, and Burnet. Both fine and coarse red granite were quarried, the latter corresponding closely to that obtained from Platte canyon, Colorado. Red and gray granites occur in Gillespie county, although no production was reported from that locality during the year.[2]

The value of siliceous crystalline rocks quarried in Texas in 1902 was reported as $60,003, and about three-fourths of this stone was used for monumental purposes. The remainder, amounting in value to $15,784, was used in building operations.

Natural gas.—While prospecting for oil and gas in the southwestern part of Washington county during 1879 a well was drilled which gave a strong flow of natural gas at a depth of about 160 feet. No practical use was made of this gas, and the first commercially successful well in this locality was not drilled until 1888.[3]

The production during 1902 was all obtained in Jefferson and Navarro counties, in the Beaumont and Corsicana oil districts. The value of the output reported by the 14 wells in operation during this year was $14,953, indicating a decrease in comparison with 1900 and 1901.

In some instances the gas obtained was used to force the flow of oil wells. It spread over the surface of the petroleum in the porous limestone, and thereby started the wells into operation.

All other minerals.—The principal mineral in Texas for which statistics may not be separately reported is gypsum, and its production ranks next to that of bituminous coal. Hardeman county was the only locality where gypsum or gypsite was quarried, and the product was sold chiefly as cement or wall plaster, although a small amount was reported as consumed in making plaster of Paris.

Cement also is quarried to a considerable extent in Dallas and Bexar counties, and in value of production ranks among the important mineral products of the state.

Silver bearing quartz is mined quite extensively in Presidio county, in the locality of the Rio Grande. Blanket deposits in limestone are found in pockets and in some places in the strata. The ore is transported in wagons to the town of Shafter, where it is reduced to the metallic state by amalgamation.

Small quantities of stoneware and fire clay were mined by individuals near Elmendorf, in Bexar county. The stoneware clay was not prepared at the mines, but was sold in the raw state to a pottery establishment.

Deposits of asphaltum and asphaltic rock exist in Texas, but the only production during 1902 was a small amount of liquid asphaltum obtained from test holes sunk by an oil and development company in Travis county.

Iron ores are found in a number of counties in Texas, and some of the product is of Bessemer quality. In character, the deposits are a brown hematite or bog ore, and the occurrences are found in a continuous and persistent ledge covering the mountains of the eastern part of the state.[4] According to the first record the iron industry in Texas was started in Cass county, where a blast furnace was in operation for some years prior to 1859. A number of other furnaces and bloomeries were also reported about this time, those in Cherokee county, near Rusk, having been established during the Civil War.[5]

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[1] Stones for Building and Decoration, page 164.

[2] Ibid., page 83.

[3] Bulletin of the University of Texas, No. 5, July, 1901, page 4.

[4] Annual Report of the Dallas Commercial Club, 1899, page 37.

[5] Iron in All Ages, by James M. Swank, page 338 ff.

UTAH.

Table 1 is a summary of the statistics of the productive mines and quarries in the state of Utah for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Gold and silver.	Coal, bituminous.	Copper ore.	Limestones and dolomites.	Sandstones and quartzites.	Siliceous crystalline rocks.	All other minerals.[1]
Number of mines or quarries	178	83	39	13	16	10	5	12
Number of operators	170	83	36	13	15	6	5	12
Salaried officials, clerks, etc.:								
Number	413	261	67	51	7	6	....	21
Salaries	$587,006	$391,317	$80,065	$71,155	$2,295	$6,720	....	$35,453
Wage-earners:								
Average number	5,712	3,349	1,576	487	103	65	1	131
Wages	$5,089,122	$3,176,599	$1,254,090	$439,612	$77,296	$50,225	$330	$90,970
Contract work	$37,054	$28,493	$340	....	$250	$500	....	$7,471
Miscellaneous expenses	$761,557	$570,250	$31,123	$71,448	$4,457	$4,460	$63	$16,756
Cost of supplies and materials	$1,835,658	$1,312,178	$196,114	$106,226	$75,046	$5,070	$130	$80,896
Value of product	$12,378,350	$8,500,904	$1,797,454	$1,459,192	$186,663	$105,011	$1,479	$327,647

[1] Includes operators as follows: Asphaltum and bituminous rock, 2; cement, 1; clay, 1; gypsum, 1; iron ore, 4; marble, 2; and sulphur and pyrite, 1.

The mineral resources of Utah constitute one of its principal sources of wealth. The state ranked third in 1902 among the states and territories in the value of gold and silver production and fourteenth in the value of all minerals.

The development of the mineral resources of the state has been slow, principally because of the lack of transportation facilities and to the fact that some of the greatest ore bodies are in almost inaccessible regions. However, the activity in developing properties within the past few years has begun to attract capital, and when the immense bodies of coal, iron, copper, and other ores that the state is known to contain are properly worked, Utah will rank among the foremost mineral producing states of the Union.

Gold and silver mining has been developed to a greater extent than any other branch of the mining industry, and the product of this class of mines in 1902 amounted to $8,500,904, or 68.7 per cent of the entire production from the mines and quarries of the state. The other minerals in the order of their importance are: Coal, bituminous; copper ore; limestones and dolomites; sandstones and quartzites; cement, asphaltum, and bituminous rock; sulphur and pyrite; gypsum; iron ore; marble; siliceous crystalline rocks; and clay.

Natural gas has been produced in Utah, but the wells which were located near Salt Lake City became choked by the decomposition of the slate forming their walls, and the industry in the state has practically been abandoned.[1]

The list of minerals found in Utah but not worked commercially is a long one, including slate, antimony, cinnabar, mineral wax, alabaster, alum, natural gas, precious stones, tripoli and pumice, saltpeter, borax, and many others. In Millard county is found the only known deposit of lump pumice stone in the United States.[2]

Among the gems to be found are some of the most beautiful and brilliant crystals of the North American topaz. These are found in considerable quantities on Thomas mountain, Deseret, an isolated and arid elevation about 6 miles long in Millard county. These crystals are larger than those from California; are always white, and evidently have been decolorized by heat or exposure to sunlight. They are equally as brilliant as those from San Luis Potosi, Mexico, which they closely resemble.[3]

Besides the work done at the productive mines and quarries in 1902, development work was done on 273 mining properties, 266 of which were gold and silver, the others being distributed among the industries of iron and manganese ores, marble, and petroleum. The operators of these properties employed 214 salaried officials, clerks, etc., to whom they paid $162,744 in salaries. They also gave employment to 966 wage-earners, and paid them $920,624 in wages. The work done by contract cost $162,745; the miscellaneous expenses amounted to $133,551, and the cost of supplies and materials was $468,505.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 653.

[2] United States Geological Survey, "Mineral Resources of the United States," 1900, page 196.

[3] Ibid., 1892, page 764.

The relative importance of manufacturing industries closely allied to or based on the mining industry, using as their raw material the product of the mines and quarries, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY	Value of product.	
All manufactures		$21,156,183
Based upon products of mines or quarries		
Clay, glass, and stone products	$497,372	
Iron and steel and their products	241,542	
Metals and metal products, other than iron and steel	7,595,594	
Miscellaneous industries	788,720	
		9,123,228
All other		12,032,955

As may be seen from the foregoing table, the value of the products of the manufacturing industries of the state based primarily upon minerals mined and quarried was $9,123,228, or 43.1 per cent of all the manufactures in the state. The value of the output of the productive mines and quarries of the state in 1902 was $12,378,350, or 36.9 per cent of the combined value of product of manufactures in 1900 and mines and quarries in 1902.

In 1902 the operators of the productive mines and quarries of Utah gave employment to 5,712 wage-earners and paid $5,089,122 in wages, and in 1900 the manufactures of the state gave employment to 6,615 wage-earners and paid $3,388,370 in wages. The total average number of wage-earners employed in mining and manufactures was 12,327, and $8,477,492 was paid in wages. Mining, therefore, employed 46.3 per cent of the wage-earners and paid 60 per cent of the wages, while manufactures contributed 53.7 per cent of the wage-earners and paid 40 per cent of the wages.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state, with the exception of copper ore, values for which can not be obtained, from 1890 to 1902.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Gold and silver.[1]	Coal, bituminous.	Limestones and dolomites.	Sandstones and quartzites.
1890	$11,023,434	$552,800	$27,568	$48,306
1891	11,963,131	666,045	(2)	36,000
1892	11,638,179	562,625	8,000	10,000
1893	10,157,907	611,092	17,116	136,402
1894	9,576,297	663,179	23,636	15,128
1895	11,028,720	617,349	22,503	5,100
1896	13,313,363	500,547	9,358	7,800
1897	9,827,078	618,230	9,250	7,907
1898	10,671,210	752,252	11,721	16,752
1899	12,621,935	997,271	6,381	29,024
1900	[3]9,718,112	1,447,750	12,749	66,783
1901	[3]10,146,680	1,666,082	78,300	38,919
1902[4]	[3]9,335,301	1,797,454	190,063	106,011

[1] Estimates by the Director of the Mint—value of the refined product, silver at coining value. The values in Table 1 are values at the mine.

[2] Not reported separately.

[3] Silver at commercial value.

[4] Census figures, except for gold and silver.

Gold and silver.—Ores of the precious metals were known to exist in Utah in the early days, but mining of most descriptions, and especially of gold and silver, was not encouraged, and it was not until 1862 that any systematic prospecting was done.[1] In that year General Connor, with the Third California Infantry, arrived and established Fort Douglas, near Salt Lake City. Many of the members of his command, who were old California prospectors, were sent out to prospect the territory, and they located mines at Stockton, Bingham Canyon, in Little Cottonwood canyon, and many other localities. Capital was obtained and attempts were made to smelt the lead-silver ore near Stockton about 1866–67, but the conditions were unfavorable, and the net result was a failure at that time. No further general activity in mining the precious metals was reported until about 1870.[2]

Ores of good quality have been found in almost every part of the state, even in the isolated mountains rising out of the desert in western Utah; but any considerable development of mining in that region must await additional facilities, especially those of transportation. From 1870 until 1886 the state's production of these metals was 135,135 fine ounces of gold and 59,065,016 fine ounces of silver.[3]

The following table, compiled from the reports of the Director of the Mint, shows separate values for the annual production of gold and silver from 1890 to 1902:

TABLE 4.—*Value of annual production of gold and silver: 1890 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	Gold.	Silver.[1]	YEAR.	Gold.	Silver.[1]
1890	$690,000	$10,333,434	1897	$1,726,100	$8,100,978
1891	650,000	11,313,131	1898	2,285,400	8,385,810
1892	660,175	10,978,004	1899	3,450,800	9,171,135
1893	853,640	9,304,267	1900	3,972,200	[2]5,745,912
1894	1,128,062	8,448,235	1901	3,690,200	[2]6,456,480
1895	1,373,000	9,655,720	1902	3,594,500	[2]5,740,801
1896	1,899,900	11,413,463			

[1] Coining value. [2] Commercial value.

The production of gold and silver in 1902, while a decrease of $811,379 from that of 1901, was 7.8 per cent of $109,415,000, estimated by the Director of the Mint as the value of the output for the United States in 1902, including silver at its commercial value.

Coal.—The first discovery of coal in Utah was made in 1851 at Coal creek, near Cedar city.[4] Mining was carried on at Wales, Sanpete county, as early as 1855, but only to a limited extent, and no general mining of coal was done until about 1876. There was but a limited development of the industry until 1888 and 1889.

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[1] Bancroft's History of Utah, page 740.

[2] Transactions of the American Institute of Mining Engineers, Vol. XVI, page 3.

[3] A Treatise on Ore Deposits, by J. A. Phillips and Henry Louis, page 760.

[4] Harper's Encyclopedia of United States History, Vol. 9, page 335.

It is estimated that over 2,000 square miles of the state's area are underlaid by workable coal, and the outcroppings for hundreds of miles in the central and southern parts are evidences of the great bodies of fuel under the surface, which, with future development, may make Utah one of the greatest coal producing states in the Rocky mountain field.[1]

The industry has made its greatest development within the past five years, the product for 1902 amounting to more than three times the product for 1897. The yearly production since 1889 has shown a steady increase, excepting in 1892 and 1896. Despite the prevailing tendency toward higher prices throughout the coal producing states in 1902, the average price per ton in Utah was only $1.14, as compared with $1.26 in 1901.[2]

The production for 1902 exceeded that of 1901 by 251,907 tons, or 19 per cent, and shows an increase in value of $131,372, or 7.8 per cent. The 39 coal mines reporting in 1902 had a combined output of 1,574,521 short tons, valued at $1,797,454, which places Utah nineteenth and twentieth, respectively, for quantity and value, in the rank of coal producing states. As in 1901, the greater part of the state's production, amounting to over 95 per cent, came from Carbon county.

Table 5, compiled from the reports of the United States Geological Survey, shows the annual production of coal in Utah, from 1876 to 1902.

TABLE 5.—*Annual production of coal, bituminous: 1876 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States".]

YEAR.	Short tons.	YEAR.	Short tons.
1876	50,400	1890	318,159
1877	50,400	1891	371,045
1878	67,200	1892	361,013
1879	225,000	1893	413,205
1880	225,000	1894	451,550
1881	225,000	1895	471,836
1882	250,000	1896	418,627
1883	250,000	1897	521,560
1884	250,000	1898	765,309
1885	213,120	1899	786,049
1886	200,000	1900	1,147,027
1887	180,021	1901	1,322,614
1888	258,961	1902	1,574,521
1889	236,651		

Copper ore.—Copper has long been produced from the Utah mines, but until quite recently the metal has been obtained only as a by-product from the smelting of gold and silver ores. Since the development of the mines of the West mountain district, Salt Lake county, the copper output has increased rapidly. The principal producers are in Salt Lake, Beaver, Tooele, Juab, Summit, and Piute counties. Some of the mines in Beaver county are among the most promising to be found anywhere at a similar stage of development.[3]

Utah is fast coming to the front as one of the important copper producing states, and the fact that the output of 23,939,901 pounds of copper, valued at $1,459,192, produced in 1902, is more than six times the production of 1898, shows what extensive development this industry is receiving.

The following table, compiled from reports of the United States Geological Survey, shows the annual production of smelted copper in Utah, from 1883 to 1902:

TABLE 6.—*Annual production of smelted copper: 1883 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Pounds.	YEAR.	Pounds.
1883	341,885	1893	1,155,590
1884	265,526	1894	1,147,570
1885	126,199	1895	2,184,708
1886	500,000	1896	3,502,012
1887	2,500,000	1897	3,919,010
1888	2,131,047	1898	3,750,000
1889	65,467	1899	9,584,746
1890	1,006,636	1900	18,354,726
1891	1,562,098	1901	20,116,979
1892	2,200,428	1902	23,939,901

Limestones and dolomites.—The value of the limestone production of the state for 1902 was $186,663, or more than double that of 1901, and over twenty times that of 1897. The limestone was used principally for burning into lime and as a fluxing material. The following counties, arranged according to the value of their production, contributed to the state's output: Salt Lake, Utah, Weber, Sanpete, Tooele, Summit, and San Juan.

Sandstones and quartzites.—Apparently inexhaustible supplies of Triassic sandstone of various shades of red and pink occur at Red Butte near Salt Lake City, and stones from this formation have been used to some extent in Salt Lake City.[4]

The value of the sandstone quarried in the state in 1902 was $105,011, or nearly three times that for 1901 and over thirteen times that for 1897. In 1902 the following counties contributed to the state's output of sandstone: Summit, Utah, Salt Lake, and Iron.

Siliceous crystalline rocks.—In Little Cottonwood canyon, not far from Salt Lake City, occurs a coarse, light gray granite in seemingly inexhaustible quantities. The stone is apparently of excellent quality and was used in the construction of the Mormon temple.[5] The value of the output of the 5 quarries productive in 1902 was $1,479, a decrease of 73.5 per cent from that for 1901. The value of the granite quarried for monumental work was $984. Beaver, Salt Lake, Utah, and Weber counties contributed to the state's output.

All other minerals.—Utah is exceptionally rich in asphaltum deposits. Bituminous limestone occurs in large quantities, but the excessive cost of transportation may prevent it becoming the source of a profitable industry for some time to come. The streets of Salt Lake City, Ogden, and other cities in the state, are paved with asphaltum produced near by, and the demand at present is confined almost wholly to the local trade. Hard varieties of asphaltum such as gilsonite and elaterite occur in several widely separated localities, frequently being associated with ozocerite. The principal localities are at Fort Duchesne in the Uinta reservation and at a place east of this reservation.[1] The gilsonite from the Uinta reservation is an exceptionally pure form of asphaltum. In spite of the fact that it has to be hauled from 70 to 100 miles to the nearest railroad point, its remarkable purity makes it possible to stand the heavy cost of transportation, and a ready market is found for the supply. Most of the output is used in making varnish, but it is also used for various other purposes.[2] No statistics can be shown without disclosing individual operations.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1888, page 374.

[2] Ibid., 1902, page 431.

[3] The Copper Handbook, by Horace J. Stevens, Vol. III, page 117.

[4] Stones for Building and Decoration, by George P. Merrill, page 164.

[5] Ibid., page 83.

Cement rock of good quality was discovered in 1888 between Ogden and Provo City, and in 1891 the first production of Portland cement from Utah was reported. The plant in operation in 1902 was at Salt Lake City and the stone used came from Parleys canyon, about 10 miles east of the city. The plant had a capacity of 600 barrels per day.[3]

The production of clay in Utah in 1902 was confined to one establishment. The clay mined was used principally for making bricks and tile.

The gypsum deposits of Utah are extensive. The demand in 1902 was for local consumption and only one plant located at Nephi was reported as active.

On the divide between the heads of Big Cottonwood and Snake creeks is a large deposit of marble, which covers many acres and is said to be many hundred feet in thickness. This marble is white in color, and is free from cracks or stains; it can be taken out in blocks as large as it would be possible for the largest machinery to handle.[4] In 1902 but two quarries in the state reported production.

Apparently inexhaustible supplies of iron ore exist in southern Utah, especially in Iron county. Beds of magnetite and hematite that bear evidence of being metamorphosed limonite, occur in limestone of uncertain Silurian age, and associated with eruptive masses, the ore forming great projecting ridges and prominent outcrops, locally called "blow-outs." These deposits occur over an area 15 by 5 miles and are in the southern end of the Wasatch mountains. The samples show rich ores, which at times exceed the Bessemer limit of phosphorus. The importance of these deposits lies in the future. They are the largest in the West, and are interesting in their bearing on the general origin of magnetite.[5] The 4 productive mines produced 16,240 tons of ore in 1902, valued at $27,417. The counties contributing to the output were Millard, Juab, and Utah.

The sulphur beds of Utah extend over a large area and in places are of remarkable purity, but the excessive cost of transportation and the development of the sulphur beds of Louisiana and other points more accessible to the market have, however, tended to curtail the production in Utah. The principal source of the production is Beaver county.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1888, page 513.

[2] Ibid., 1892, page 702.

[3] Ibid., 1902, pages 807 and 808.

[4] United States Geological Survey, "Mineral Resources of the United States," 1889-90, page 432.

[5] Ore Deposits of the United States, by James F. Kemp, page 128.

VERMONT.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Vermont for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Marble.	Siliceous crystalline rocks.	Slate.	Limestones and dolomites.	All other minerals.[1]
Number of mines or quarries	192	22	74	76	14	6
Number of operators	160	16	68	58	13	5
Salaried officials, clerks, etc.						
Number	433	195	128	97	12	1
Salaries	$376,077	$184,877	$104,650	$78,442	$7,958	$150
Wage-earners:						
Average number	5,398	2,074	1,505	1,639	156	24
Wages	$3,114,399	$1,206,208	$958,950	$874,263	$65,083	$9,895
Miscellaneous expenses	$382,731	$226,103	$70,650	$79,700	$5,810	$468
Cost of supplies and materials	$1,016,143	$523,075	$272,888	$102,410	$116,301	$1,469
Value of product	$5,604,705	$2,628,164	$1,570,423	$1,164,918	$225,703	$15,497

[1] Includes operators as follows: Buhrstones and millstones, 1; clay, 2; iron ore, 1; mineral pigments, crude, 1; oilstones, whetstones, and scythestones (1 quarry—operator reported in Arkansas).

The great bulk of the mineral wealth of Vermont lies in its vast rock deposits, comprising marble, granite, limestone, slate, etc. The quarrying of these rocks began more than a hundred years ago, and at an early date some of them, notably marble, granite, and slate, brought the state into national prominence; later, through superiority of quality and especial fitness for certain uses, these products were shipped beyond the limits of the United States and found a market in practically every civilized country of the world.[1]

The range of metalliferous ores in the state is quite limited, and these, excepting copper, have not been found in such quantities as to warrant extensive exploitation.

There are several minerals occurring in the state for which no production in commercial quantities was reported in 1902. Among them is asbestos, which was discovered at numerous places in the state many years ago. It has been during the last few years only, however, that any systematic development of the deposits has been attempted.[2] In 1902 these operations were carried on in the north central part of the state, in the towns of Eden, Lamoille county, and Lowell, Orleans county.[3] The Vermont asbestos is of good quality and exists in great abundance.

Copper ores occur extensively in eastern Vermont, particularly in Orange county, and considerable quantities have been extracted in the past. In this region there were four mines, one of which was worked long before the development of the Lake Superior mines, and reached a depth of over 1,500 feet.[4] The present owners have expended large sums in installing new and modern machinery and methods, and have given evidence of an intention to develop the property on a large scale.[5]

Ilmenite, the most abundant of all the titanium minerals, occurs to some extent in combination with varying quantities of ferric oxide. Rutile, one of the allied minerals, also occurs in the state.[6]

Mica, while of quite general occurrence throughout the state in the form of small flakes, has been found in deposits of commercial importance in only one locality. This bed is at Sherburne.

Talc and soapstone have been found and mined in Vermont, although there was no production reported for 1902. The known deposits occur in many localities in the state, notably in Grafton,[7] and operations are being resumed at Rochester, Windsor county, on a property which was worked rather extensively during 1865 and 1866.[8]

Gold has been found in small quantities at some places in the state, but its mining has not proved profitable.

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[1] Report of the Vermont State Geologist, 1901–2, page 40.

[2] United States Geological Survey, "Mineral Resources of the United States," 1900, pages 862 and 863.

[3] Report of the Vermont State Geologist, 1901–2, pages 34 and 35.

[4] Report of the Vermont State Geologist, 1901–2, page 81.

[5] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 8.

[6] United States Geological Survey, "Mineral Resources of the United States," 1901, page 272.

[7] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 77.

[8] United States Geological Survey, "Mineral Resources of the United States," 1902, page 867.

The relative importance of manufacturing industries closely allied to or based upon the mining industry, using as their raw material the products of mines and quarries, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$57,623,815
Based upon products of mines or quarries:		
Chemicals and allied products	$407,337	
Clay, glass, and stone products	6,936,749	
Iron and steel and their products	4,939,690	
Metals and metal products, other than iron and steel	410,643	
Miscellaneous industries	1,319,382	
		14,013,801
All other		43,610,014

Table 2 shows that the total value of the state's manufactures in 1900 amounted to $57,623,815, and that of this sum $14,013,801, or 24.3 per cent, was the value of the product of manufacturing establishments using as their raw material the products of mines and quarries. For 1902 the reported value of the output of the mines and quarries of the state was $5,904,705, or 9.3 per cent of the combined value of the state's manufactures in 1900 and mining and quarrying in 1902.

As reported at the census of 1900, the manufactures of the state employed on an average 29,455 wage-earners during the year and paid $12,237,684 in wages. The corresponding figures for mines and quarries in 1902 were 5,398 wage-earners and $3,114,399 paid in wages. Comparing the figures for manufactures and mines and mining, it is seen that manufactures employed 84.5 per cent of the wage-earners and paid 79.7 per cent of the wages, while mines and quarries gave employment to 15.5 per cent of the wage-earners and paid 20.3 per cent of the wages.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR	Marble.	Siliceous crystalline rocks.	Slate.	Limestones and dolomites.
1890	$2,169,560	$581,870	$842,013	$195,067
1891	2,200,000	700,000	955,617	175,000
1892	2,275,000	675,000	1,014,000	200,000
1893	1,621,000	778,459	530,732	151,067
1894	1,500,399	893,956	658,167	408,800
1895	1,321,598	1,007,718	625,330	300,000
1896	1,191,557	895,516	609,606	147,158
1897	2,050,229	1,074,300	695,845	165,667
1898	2,067,238	1,084,218	732,684	174,150
1899	2,241,806	1,212,967	872,673	282,173
1900	2,481,852	1,113,788	917,462	188,100
1901	2,758,583	1,245,828	1,162,191	205,138
1902	2,628,164	1,570,428	1,464,918	225,700

Marble.—Vermont leads all other states in the production of marble. The total value of the output of this stone in the United States in 1902 was $5,044,182, and of this amount Vermont contributed $2,628,164, or 52.1 per cent.

Marble has been quarried in Vermont for more than a century, the earliest authentic record of such work having been made in 1785.[1] In 1902 the state's output of marble came from the quarries in Rutland, Bennington, Franklin, Chittenden, and Grand Isle counties, though the stone is of known occurrence at many other localities in the state.[2] The most famous of Vermont marble beds are those of West Rutland, and the name "Rutland marble" is used to designate either that from these quarries or from Proctor.[3] Important quarries are also located at Dorset and East Dorset, in Bennington county. Much of this stone is of the finest quality and is used for monuments, decorative work, and for statues, as well as for general building purposes.[4]

The color effects of Vermont marble are many and beautiful, ranging from pure white through all shades of blue, and sometimes green, to deep blue-black, often being beautifully mottled and veined. The dark varieties, as a rule, are the most durable and valuable, although the white is in the greatest demand for monumental and statuary work. This stone differs from the marble of Italy in being of a dead white color and lacking the luster so characteristic of the Italian product. Marbles of different shades of gray, with sinuous veins, as well as some of red, pink, and chocolate colors, plain and mottled, are also found.[5] Black marble is found at Isle La Motte, in Grand Isle county.

Since the deposits in Vermont are of great thickness, the quarries occasionally reach a considerable depth, or in following the vein the opening is pushed far under a hill and forms a cavern, the walls and roof of which are supported at intervals by enormous piers left for that purpose.

The value of the marble, both rough and dressed, that was used for monumental purposes, amounted to $758,390, or 28.8 per cent of the total, while the value used for building purposes amounted to $433,265, or 16.5 per cent of the total.

Siliceous crystalline rocks.—The occurrence of extensive granite deposits in Vermont has been known since the state was first settled.[6] Notwithstanding this knowledge, the quarrying of granite as an industry of importance has had its growth almost entirely since 1880, although small quantities of the stone were taken out much earlier.[7] Granite has been uncovered in apparently inexhaustible quantities in all parts of the state, though the center of the granite quarrying industry is at Barre and Woodbury, in Washington county. In fact, the former place, now a thriving city, owes practically its whole importance to the quarrying of this stone.[1]

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[1] One Hundred Years of American Commerce, Vol. 1, page 189.

[2] United States Geological Survey, Sixteenth Annual Report, 1894–95, Part IV, page 469.

[3] Report on the Marble, Slate, and Granite Industries of Vermont, by George N. Perkins, page 16.

[4] Stones for Building and Decoration, by George P. Merrill, page 235.

[5] Ibid., pages 233 to 237.

[6] Report on the Marble, Slate, and Granite Industry of Vermont, page 51.

[7] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 57.

Vermont granites vary in color, from light to dark gray and range in texture from coarse to very fine.[2] The granite of Barre, is of the best quality known, and is used to a very large extent for monuments and fine decorative work, because it takes a fine polish, and stands exposure to weather without apparent injury.[3] The stone occurs in thick strata, and can be taken out in immense blocks which adds greatly to its value as a structural material.[4]

In 1902 Vermont ranked third among the granite producing states with a product valued at $1,570,423, or 26.6 per cent of mineral output of the state, and 8.6 per cent of total value of product of the industry in this country.

The value of the granite, both rough and dressed, that was used for monumental purposes, amounted to $1,209,194, or 77 per cent of the state's production, while the value of that used for all other purposes amounted to $361,229, or 23 per cent.

Slate. Although slate is found in a majority of the counties of the state, there are three distinct belts traversing the eastern, middle, and western parts of the state. Of these, the western belt, especially that section lying in Rutland county, is by far the most important, and it is here that the well-known quarries at Castleton, Fair Haven, Poultney, Wells, and Pawlet are located.[5]

The first slate quarry in Vermont is said to have been opened in 1805,[6] although the year 1839 is usually considered to be the date of the beginning of the industry in the state. It was, however, not until 1845 that the quarrying of this stone began to assume the proportions of an important branch of the mineral industry of the state.[7]

In Vermont slate is found in many colors, the most common of which are green, purple, black, red, and chocolate, with the variegated or mottled varieties,[7] a single quarry not infrequently producing several different colors of stone. Of the green shades, there are two classes known as "sea green" and "unfading green," both being used extensively for roofing purposes, the unfading green retaining its color permanently, while the sea green, upon exposure to weather, turns to a yellowish brown. The quality of the two is about the same, and where fine artistic effect is not sought the sea-green variety is equally satisfactory.[8]

The quarries are all open pits, ranging in depth to as much as 300 feet. The quarrying of slate is attended by an enormous waste of material, not more than one-sixth of the total quantity of rock removed being available for use, and the dump piles grow with such rapidity and to such size as to become a serious hindrance to the progress of the work.[9]

The state's product of slate in 1902 amounted in value to $1,464,918, or 24.8 per cent of the total value of its output of all minerals. Of this amount, 91.4 per cent was used for roofing purposes. Vermont ranked second among the states in 1902 in the production of slate, and the output was valued at 25.7 per cent of the total yield of the country. It was put to the usual uses, including roofing, school slates, beds for billiard tables, etc. Large quantities of domestic slate are exported and the demand increases steadily.[10]

Limestones and dolomites. The most important deposits of limestone are found in Washington and Orange counties.[11] The stone has been quarried on the southern end of Isle La Motte for over a century, the quarry being nowhere much below the level of the lake.[12] The stone is thickly bedded, thus permitting the removal of blocks 15 or 16 feet in thickness, and ranges in color from white to dark gray or black. The value of the stone burned for lime formed 97.2 per cent of the total product.

All other minerals.—The only quarry credited to Vermont as having produced buhrstones and millstones in 1902 is in Rutland county.

Clay has been found in Grand Isle county, some of the deposits being 25 feet thick, and in small quantities in various other parts of the state.[13] In 1902 a production was reported by two establishments located in Bennington county.

An iron ore mine located near Brandon, Rutland county, reported a small production for 1902. The ore has also been found at Monkton, Bennington, and other localities, mostly in the southern part of the state.[14] It usually occurs in the form of bog ore and limonite, and was first discovered at Brandon in 1810, soon after which a forge and furnace were erected there. In the same vicinity ocher has been discovered.[15]

In 1902 small amounts of ocher, iron, and metallic substances were extracted in Rutland county and, being ground for paints, were classified as crude mineral pigments. Aside from the small value they added to the total mineral output of Vermont, these serve chiefly to show the diversity of Rutland county's mineral wealth.

There was one quarry in Orleans county from which a production of oilstones, whetstones, and scythestones was reported in 1902.

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[1] Report on the Marble, Slate, and Granite Industry of Vermont, page 55.

[2] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 57.

[3] Ibid., pages 57 and 58, and 61 to 66.

[4] Report on the Marble, Slate, and Granite Industries of Vermont, pages 58 to 67.

[5] Stones for Building and Decoration, pages 195 and 196.

[6] Report on the Marble, Slate, and Granite Industries of Vermont, page 43.

[7] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 17 ff.

[8] The Mineral Industry, 1897, Vol. VI, page 599.

[9] The Mineral Industry, 1897, Vol. VI, pages 600 and 607.

[10] Ibid., page 609.

[11] Report of the Vermont State Geologist, 1899–1900, page 30 ff.

[12] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 31.

[13] Report of the Vermont State Geologist, 1901–2, page 111.

[14] Report of the State Geologist on the Mineral Resources of Vermont, 1899–1900, page 15.

[15] Report of the Vermont State Geologist, 1901–2, pages 14 and 15.

VIRGINIA.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Virginia for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous	Iron ore	Limestones and dolomites	Sulphur and pyrite	Cement	Siliceous crystalline rocks	Slate	Manganese ore	All other minerals[1]
Number of mines or quarries	192	26	62	37	6	3	27	4	6	31
Number of operators	140	22	25	28	4	3	17	4	6	31
Salaried officials, clerks, etc.:										
Number	700	179	257	63	32	43	21	15	10	80
Salaries	$546,204	$155,930	$174,034	$35,450	$29,970	$44,675	$12,904	$11,190	$4,241	$77,501
Wage earners:										
Average number	8,993	3,004	2,686	890	655	178	463	247	113	751
Wages	$3,458,440	$1,407,867	$888,958	$280,379	$222,986	$83,423	$190,322	$97,645	$55,865	$242,677
Contract work	$35,964	$27,600	$6,730		$1,134					$500
Miscellaneous expenses	$673,200	$315,384	$120,563	$21,898	$23,285	$31,487	$12,466	$24,866	$940	$50,241
Cost of supplies and materials	$928,287	$215,458	$291,426	$136,956	$137,491	$91,106	$22,290	$30,963	$8,691	$104,011
Value of product	$6,667,867	$2,543,596	$1,652,799	$585,113	$501,642	$327,659	$282,046	$166,951	$20,444	$574,558

[1] Includes operators as follows: Asbestos, 1; barytes, 3 (4 mines); buhrstones and millstones, 3; copper ore, 1; flint, 1; gold and silver, 5; gypsum, 2; infusorial earth, tripoli, and pumice, 2; lead and zinc ore, 2 (3 mines—operator reported under iron ore); marl, 1; mica, 2; mineral pigments, crude, 2; precious stones, 3 (no mines); rutile, 1; sandstones and quartzites, 2; talc and soapstone, 2.

The range of mineral industry in Virginia in 1902 was wide and varied, comprising within its scope the production on a commercial scale of twenty-four different minerals. First among these in point of value was the production of bituminous coal, obtained in the main from the vast deposits of high-grade steam and coking coal in the southwestern part of the state. It is this region that furnishes the celebrated Pocahontas coal. Iron ore, which was extensively produced in 1902, occurs among the mountains in deposits of remarkable richness, the beds of ore being from 20 to 100 feet in thickness and many miles long. For 300 miles the western foothills of the Blue Ridge are lined with brown hematite ore and solid masses of it appear along the Alleghenies.[1] The yield of brown hematite from this region comprises an important percentage of the total output of this variety in the country, and also constitutes the bulk of iron ore production in the state.

The industry of manganese ore mining had its beginning in Virginia, and more than one-half of the total output of this mineral in the United States has been contributed by the mines of this state, during the third of a century of manganese ore exploitation in the country.

The lead and zinc deposits of Wythe county have been worked for more than a hundred and twenty-five years, and furnished lead to both the Continental and Confederate Armies.[2]

The great gold belt, 200 miles in length, which stretches from the Potomac to the Dan, has furnished more than $2,000,000 worth of gold to the Mint.[1]

The copper deposits of the state are extensive, especially in southwestern Virginia,[3] and the noted deposits of Louisa county have long been the seat of an important industry.[4]

The sandstones of the Blue Ridge, the limestones and slates of the valleys, and the granites which are widely distributed afford an abundant supply of building materials, and their exploitation constitutes an important industry in the state.[4]

From the fertilizing marls and greensands of Tidewater westward to the vast coal and metalliferous deposits near the Kentucky and West Virginia lines is spread a great variety of mineral wealth, which affords such basis as to make the mining industry an important factor in the industrial activity of the state.

The following is a list of minerals of known occurrence in Virginia which were not produced commercially in 1902: Allanite, alum, arsenic, bismuth, carbonite, feldspar, fire clay, kaolin, marble, plumbago, quartz, serpentine, and tin.

Work of a developing character, where no production was realized from the mining properties, was reported by 5 operators, and was confined during 1902 to gold and silver and manganese ore. These operators paid $4,535 to 8 salaried officials, clerks, etc., during 1902, and gave employment to an average number of 51 wage-earners who received $17,964 in wages. Contract work amounted to $158, miscellaneous expenses to $9,752, and the cost of supplies and materials to $26,305.

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[1] King's Handbook of the United States, page 858.

[2] Transactions of the American Institute of Mining Engineers, Vol. V, page 85.

[3] Transactions of the American Institute of Mining Engineers, Vol. V, page 81 ff.

[4] The New International Encyclopedia, Vol. XVII, page 374.

The relative importance of manufacturing industries closely allied to or based upon the mining industry, using as their raw material the products of mines and quarries, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product	
All manufactures		$132,172,910
Based upon products of mines or quarries:		
Chemicals and allied products	$4,483,348	
Clay, glass, and stone products	2,121,195	
Iron and steel and their products	13,549,769	
Metals and metal products, other than iron and steel	1,698,151	
Miscellaneous industries	5,419,898	
		27,272,601
All other		104,900,309

The total value of the products of the manufacturing industries based upon mining was $27,272,601, or 20.6 per cent of the total value of the product of all manufacturing industries in the state in 1900. During the same year there were employed in all branches of manufacture in the state 72,702 wage-earners, who were paid $22,445,720 in wages. In 1902 there were employed in the mines and quarries of the state 8,993 wage-earners, who received $3,458,450 in wages. Comparing the figures for these two branches of industry, it will be seen that 89 per cent of the wage-earners, receiving 86.6 per cent of the wages, were employed in manufacturing, while 11 per cent of the wage-earners, receiving 13.4 per cent of the wages, were employed in mining.

The following table, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Iron ore.	Limestones and dolomites.	Cement.	Siliceous crystalline rocks.	Slate.	Manganese ore.
1890	$589,925	(1)	$159,023	[2]$45,000	$332,548	$113,079	$125,121
1891	647,651	(1)	170,000	18,000	300,000	127,819	180,832
1892	578,429	[2]$1,128,801	185,000	10,000	300,000	150,000	58,966
1893	692,748	[2]1,050,977	82,685	15,084	103,702	117,347	30,892
1894	903,576	[2]873,506	284,547	8,700	125,361	138,151	16,058
1895	869,873	987,077	268,892	7,880	70,126	111,357	[illegible]
1896	848,851	1,220,619	182,640	10,766	95,010	107,863	21,180
1897	1,021,918	974,031	192,972	9,139	88,095	115,370	[illegible]
1898	1,070,417	1,226,290	182,862	5,401	125,189	150,946	56,925
1899	1,304,251	[2]1,766,410	255,600	38,100	223,880	183,110	75,000
1900	2,123,222	[2]1,189,318	403,318	88,288	211,080	130,211	60,921
1901	2,358,989	[2]1,166,123	539,128	(3)	275,701	178,979	42,856
1902[4]	2,543,695	1,652,799	535,113	527,659	282,046	160,951	29,411

[1] Not reported separately.
[2] Includes production from West Virginia.
[3] Reported with the production for Ohio.
[4] Census figures.

Coal. The mining of coal in Virginia, and in the United States, began in 1775, near Richmond; its occurrence in this locality, however, had been noted some five years earlier.[1] From the beginning of the industry of coal mining until 1789 the entire output went to supply the local demand. During 1789 the product of the mines began to find a wider market in the northern cities, and for many years the bituminous coal deposits of the Richmond basin were the only source from which this mineral could be procured and shipped coastwise.[2] The product sent out in this way to other cities had grown in 1822 to 48,000 tons and in 1833 to 143,000 tons.[2] About this time the discovery and development of other coal areas carrying deposits of superior quality and more economical of exploitation caused a rapid decline in the output of this region. By the middle of the century the production of coal in this field had practically ceased. For more than a quarter of a century the output of coal in the state was insignificant, but the building of the Norfolk and Western Railway, in 1883, was followed by the development of the great coal deposits of southwestern Virginia, notably the Pocahontas region, and the state soon came again into prominence as a coal producer. In 1880 the total coal production of the state was only 112,000 short tons, but in 1889, or seven years after operations in the new fields were under way, the output had increased to 865,786 short tons, and in 1902 had reached a total of 3,182,993 short tons.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in the state from 1822 to 1902:

TABLE 4.—*Annual production of coal, bituminous: 1822 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1822	54,000	1849	15,000	1876	85,000
1823	60,000	1850	10,000	1877	90,000
1824	67,040	1851	10,000	1878	96,000
1825	75,000	1852	25,000	1879	105,000
1826	88,720	1853	50,000	1880	112,000
1827	94,000	1854	70,000	1881	112,000
1828	100,080	1855	80,782	1882	112,000
1829	100,000	1856	52,687	1883	252,000
1830	102,800	1857	63,605	1884	336,000
1831	118,000	1858	77,690	1885	567,000
1832	132,000	1859	59,055	1886	684,951
1833	125,000	1860	61,759	1887	825,263
1834	124,000	1861	45,165	1888	1,073,000
1835	120,000	1862	45,124	1889	865,786
1836	124,000	1863	40,000	1890	784,011
1837	110,000	1864	40,000	1891	736,399
1838	107,999	1865	40,000	1892	675,205
1839	96,000	1866	40,000	1893	820,339
1840	88,000	1867	50,000	1894	1,229,083
1841	79,000	1868	59,861	1895	1,368,324
1842	73,640	1869	65,000	1896	1,254,723
1843	70,000	1870	62,219	1897	1,528,302
1844	65,000	1871	70,000	1898	1,815,274
1845	50,000	1872	69,110	1899	2,105,791
1846	40,000	1873	67,200	1900	2,393,754
1847	25,000	1874	70,000	1901	2,725,873
1848	18,000	1875	80,000	1902	3,182,993

The coal deposits of the state occur in two distinct areas. The first of these, that in which the industry of coal mining in the country had its inception, comprises the counties of Henrico, Chesterfield, and Goochland, and parts of Powhatan and Amelia; the second, and by far the more important field of the state, is a part of the great Appalachian region and lies in the southwestern part of the state.[1] Perhaps the most remarkable and valuable occurrence of bituminous coal to be found in the United States in association with vast deposits of metalliferous ores is that forming the southeastern portion of the Kanawha basin and comprising Tazewell, Russell, Scott, Buchanan, Wise, and Lee counties.[2]

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[1] United States Geological Survey, Twenty-second Annual Report, Part III, page 38.
[2] Statistics of Coal, by R. C. Taylor, page 21.

Iron ore.—Probably the first iron ore mining in the New World occurred in Virginia, for on April 10, 1608, a ship belonging to the Virginia Company of London sailed from Jamestown loaded with iron ore and other commodities, reaching England on May 20. The record of this first exploitation of American ore by Europeans states that this ore was smelted and 17 tons of metal were sold at £4 per ton.[3]

For several years following numerous attempts were made by the Virginia Company to establish the industry of iron manufacture in the vicinity of Falling creek. Under the direction of John Berkley, who was sent out by the company in 1621, the construction of several plants for the reduction of the ore was begun. However, just when these works were nearing completion and the prospects for a rapid development of the industry were bright, the colony was massacred by the Indians, on March 22, 1622. There is no record of further efforts to manufacture iron in the colony for many years. In 1687 and again in 1696 Col. William Byrd set on foot a plan to rebuild these works, but the project never materialized.[4]

In the eighteenth century, however, the colony became very prominent in the manufacture of iron and fulfilled in an eminent degree, though at a much later day, the expectations which had been entertained of its iron producing capabilities by the enterprising but unfortunate Virginia Company of London.[4]

To Col. Alexander Spotswood, who was governor of the colony from 1710 to 1723, has been accredited the honor of establishing the iron industry of the state on a firm and permanent basis. During this period a colony of German Protestants settled at the head of the Rappahannock river, with the hope of locating mines. It is probable that the first furnace in the state was owned by Governor Spotswood and was built and operated in 1715 or 1716 by these German miners, who were in his employ.[5]

The industry of iron making, the growth of which was stimulated by encouragement from the colonial government, spread rapidly into other localities and at the beginning of the Revolution was an important factor in the industrial development of the colony.[6]

In common with other industries, iron making took a fresh start subsequent to the War of the Revolution and for many years no state in the Union gave closer attention to domestic manufactures than Virginia. As the result of various causes, however, the iron industry in Virginia declined rapidly toward the middle of the nineteenth century and by 1856 many of the furnaces and forges had been abandoned.[6]

A new era of activity in iron working in Virginia opened, however, with the discovery of vast deposits of high-grade ore in the southwestern part of the state. This was followed by extension of railroads into the region and the exploitation of the celebrated coal deposits of the Pocahontas Flat Top district, and has resulted in a reawakening in the industry that has again brought the state into prominence as an iron producer.[7]

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of iron ore in the state from 1890 to 1902:

TABLE 5.—*Annual production of iron ore: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1890	543,583	1897	711,128
1891	658,916	1898	557,713
1892	741,027	1899	[1] 985,476
1893	[1] 616,985	1900	[1] 921,821
1894	[1] 620,562	1901	[1] 925,394
1895	712,241	1902	[1] 987,958
1896	859,165		

[1] Includes production from West Virginia.

Limestones and dolomites.—The predominating rocks of the region west of the Blue Ridge are the limestones. This region has long been famous for the occurrence of natural curiosities in the limestone formations, such as Weyers cave, in Augusta county, the caves of Luray, in Page county, and the Natural Bridge, the arched remnant of a cave, in Rockbridge county.[8]

The limestones have been quarried extensively at numerous places, but have been used to only a very limited extent for building purposes, the bulk of the output being utilized for making lime and as a flux in the reduction of ores.

Sulphur and pyrite.—The extensive pyrite deposits of the state, and especially those of Louisa county, where practically inexhaustible quantities occur, have long been exploited. The bulk of the product of these mines has gone into the manufacture of sulphuric acid, the demand for which commodity has increased materially during the last decade, as a result of its extended use in the manufacture of paper from wood pulp and in the manufacture of superphosphates from phosphate rock, in which latter process a chemically pure sulphuric acid is not essential and that made from pyrite serves the purpose equally as well as that made from sulphur.[1]

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[1] Coal Statistics, published by Alder & Rutley, 1902, page 164.

[2] Transactions of the American Institute of Mining Engineers, Vol. VIII, page 343.

[3] Iron in All Ages, by James M. Swank, page 103.

[4] Ibid., pages 103 to 107.

[5] Ibid., pages 258 and 259.

[6] Iron in All Ages, pages 261 to 269.

[7] Ibid., pages 269 to 271.

[8] The New International Encyclopedia, Vol. XVII, page 374.

In the production of pyrite, the importance of which is rapidly increasing, Virginia took first rank in 1902, with an output valued at $501,642, or 64.7 per cent of the total yield of this mineral in the United States.

Cement.—The industry of the manufacture of cement from natural rock in Virginia dates from 1835 and had its beginning in Rockbridge county. The quality of this first product was excellent. Works were established at Balcony Falls in 1848; subsequently this plant was destroyed by flood and later was rebuilt on a more extended scale at Locker, a short distance away, where it is at present in operation and enjoys the distinction of being the oldest active cement plant in the state. Another large and important cement plant is located near Staunton, at Craigsville. It was built in 1900, and in 1902 contributed an important percentage of high-grade cement to the total output of this mineral in the state.[2]

Table 6, compiled from the reports of the United States Geological Survey, shows the annual production of cement from 1890 to 1902.

TABLE 6.—*Annual production of cement: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels.	YEAR.	Barrels.
1890	[1] 50,000	1897	15,232
1891	20,000	1898	8,855
1892	10,000	1899	63,500
1893	17,502	1900	83,792
1894	11,500	1901	(2)
1895	13,060	1902	368,869
1896	16,776		

[1] Includes production from West Virginia.
[2] Included in the production of Ohio.

Siliceous crystalline rocks.—The production of building stone has long been an important industry in the state, and the output of the Virginia granite quarries has been used in many notable structures. Among these is the State, War, and Navy Department building at Washington.[3]

The siliceous crystalline rocks of the state are confined in the main to a belt or zone running from Alexandria county through Fairfax, Fauquier, Spottsylvania, Henrico, Goochland, Chesterfield, Dinwiddie, and Greenesville counties, into North Carolina. While a wide area of occurrence is comprised within this belt, the outcrops of quarriable granite are confined to a very limited part of this region, the principal points being in Chesterfield and Dinwiddie counties, on the James river, and in the immediate vicinity of Richmond.

The product of the quarries in the vicinity of Richmond and of those in Chesterfield county is a massive gray granite, well adapted for general building purposes, paving stone, and monumental work. This granite has found a market in practically all the states and cities south of New England and as far west as Nebraska.[3]

Slate.—The occurrences of slate in deposits of commercial importance are distributed over a considerable area in Virginia and have been exploited in numerous places. The principal producing district in 1902, and that within which the industry of slate quarrying in the state most probably had its origin, was in Buckingham county.[4] Smaller products were also reported from Amherst and Albemarle counties. Abundant deposits of this mineral have been found and developed to a limited extent in the Great Valley and Appalachian districts.[5]

Manganese ore.—The beginning of manganese ore mining in Virginia, and perhaps in the United States, occurred in 1857 in the Shenandoah valley, about 100 tons being taken out during that year. In 1868 and 1869 about 5,000 tons of manganese ore were taken out near Warminster, and this marks the beginning of systematic manganese ore mining in the state.[6]

For many years the states of Virginia and Georgia have contributed the bulk of the output of this valuable mineral in the United States, nearly all the yield being exported to England. The period of greatest activity in manganese mining in the state was that beginning in 1885 and closing with 1891, during which years the average annual production was about 15,000 tons, the maximum output occurring in 1886, when the total was 20,567 long tons. There has been a marked decline in the state's production in recent years.

Table 7, compiled from reports of the United States Geological Survey, shows the annual production of manganese ore in the state from 1880 to 1902, inclusive, during which period the state contributed more than 55 per cent of the total output of this mineral in the country.

TABLE 7.—*Annual production of manganese ore: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
Total	191,067	1891	16,248
1880	3,661	1892	6,079
1881	3,295	1893	4,092
1882	2,982	1894	1,797
1883	5,355	1895	1,715
1884	8,980	1896	2,018
1885	18,745	1897	3,650
1886	20,567	1898	5,662
1887	19,835	1899	6,228
1888	17,646	1900	7,881
1889	14,616	1901	4,275
1890	12,699	1902	3,041

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 941.

[2] Ibid., page 808.

[3] Stones for Building and Decoration, by George P. Merrill, pages 85 and 86.

[4] United States Geological Survey, "Mineral Resources of the United States," 1882, page 742.

[5] The Universal Cyclopedia, Vol. 12, page 211.

[6] United States Geological Survey, "Mineral Resources of the United States," 1892, page 202 ff.

The known occurrences of manganese ore in the state are widely distributed, being practically coextensive with its area. Beginning with the pocket occurrences in the eastern part or Tidewater district, manganese ore has been found and mined in the Midland, Piedmont, Blue Ridge, Valley, Appalachia, and trans-Appalachia divisions westward to the West Virginia line. The great bulk of the state's output, however, has come from the Valley region.[1]

All other minerals.—Asbestos, which occurs in numerous places in western and southwestern Virginia,[2] was mined to a limited extent during the year. Barytes of good quality and in large quantities occurs at many points in the southern and southwestern parts of the state, notably in Campbell county in the vicinity of Lynchburg,[3] and its mining has for many years been of relative importance. The output of this mineral in Virginia in 1902 comprised more than one-fifth of the total production in the country.

Buhrstones and millstones were obtained from granitic rocks at several places in the state, the production for 1902 constituting nearly 20 per cent of the total value of production of the United States.

Copper ores occur extensively in southwestern Virginia and in some other sections of the state, especially in Louisa county near Talersville.[4] Copper was produced on a commercial scale in 1902 at only one mine.

Virginia became a producer of flint in 1902, though the output was small and was confined to one mine.

Gold and silver in a limited way has been a mineral product of the state for more than a century and a quarter. The first recorded discovery of gold in the state was that noted in the papers of Thomas Jefferson. About 4 miles below the falls on the Rappahannock river there was found a lump of ore weighing 4 pounds; this yielded, when treated, 17 pennyweights of gold.[5] Gold is of wide occurrence in the state, and extensive mining operations have been prosecuted at different times over a wide area. The principal deposits occur within the Virginia gold belt, which extends from the Potomac river to Halifax county, a distance of about 200 miles, with a width varying from 15 to 25 miles.[6]

Gypsum, the producing localities of which are the Holston river fields around Saltville, was mined in 1902 to a limited extent at two points, though in former years large quantities of this mineral were taken out.[7]

An extensive bed of infusorial earth is traceable from the Patuxent river in Maryland to the Meherrin in Virginia. Exposed patches occur at Richmond and other points.[8] The output in 1902 was limited to the production of two concerns.

A small quantity of lead ore was produced in 1902 at two mines, the work being carried on in connection with the mining of iron ore. Extensive deposits of lead ore occur in southwestern Virginia, and lead mining was begun in this region more than a century ago.[8]

The marls which occur in the eastern part of the state were mined to a limited extent during the year, one establishment reporting production. Virginia and New Jersey mined the entire production of marl in the United States in 1902.

Mica occurs in numerous places, notably in Hanover, Goochland, Bedford, Henry, and Amelia counties.[8] The production in 1902 was from two mines.

Mineral paints were produced to a limited extent during the year in Bedford and Page counties.

While no mining operations were prosecuted for precious stones, specimens of value were picked up in a number of places.

Deposits of rutile occur on both sides of the Tye river near Roseland post office, in Nelson county, and the production of this mineral during the year was confined to the output of one company operating in this vicinity.

Sandstones and quartzites were quarried during the year on a commercial scale at two points. The occurrence of these rocks in the state is extensive.[9]

Numerous occurrences of soapstone have been noted in the state, notably in the southern and southwestern parts. In Campbell county there is a continuous belt traceable for miles.[10] The product of the state in 1902 was reported from two mines.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1892, page 202 ff.

[2] Ibid., 1882, page 738.

[3] Ibid., page 741.

[4] Ibid., 1887, page 799.

[5] Ibid., Sixteenth Annual Report, 1894-95, Part III, page 256.

[6] United States Geological Survey, "Mineral Resources of the United States," 1887, page 800.

[7] King's Handbook of the United States, page 858.

[8] United States Geological Survey, "Mineral Resources of the United States," 1887, page 803.

[9] The New International Encyclopædia, Vol. XVII, page 374.

[10] United States Geological Survey, "Mineral Resources of the United States," 1887, page 802.

WASHINGTON.

Table 1 is a summary of the statistics for the productive mines and quarries of the state of Washington for 1902.

TABLE 1.—SUMMARY: 1902.

	Total	Coal, bituminous.	Gold and silver.	Limestones and dolomites.	Siliceous crystalline rocks.	Marble.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	90	27	31	12	9	5	3	3
Number of operators	84	22	31	12	8	5	3	3
Salaried officials, clerks, etc.:								
Number	258	160	34	22	20	12	4	6
Salaries	$328,290	$221,915	$36,065	$35,701	$11,948	$10,400	$4,100	$8,160
Wage-earners:								
Average number	4,567	3,931	229	147	137	63	32	28
Wages	$3,735,464	$3,220,263	$232,068	$87,850	$95,919	$46,099	$23,237	$30,028
Contract work	$29,600	$200	$29,400					
Miscellaneous expenses	$225,161	$180,213	$23,651	$8,298	$2,644	$9,350	$550	$455
Cost of supplies and materials	$315,807	$176,184	$55,688	$28,425	$21,264	$22,349	$1,315	$10,582
Value of product	$5,413,659	$4,572,295	$338,351	$213,814	$147,273	$81,176	$30,725	$30,025

[1] Includes operators as follows: Clay, 1; copper ore, 1; molybdenum, 1.

The large, mountainous area abounds in rich deposits of useful and precious minerals awaiting only the further progress of development operations and improved transportation facilities to become valuable workings. The coal fields have thus far received the greatest attention, the product of coal mines in 1902 amounting to 84.7 per cent of the total mineral production in the state.

There was no production, on a commercial scale, of iron ores in 1902, although deposits of considerable extent are known to occur in the state. The iron ores found in Washington are magnetites, hematites, limonites, and mixtures of hematite and magnetite, and the localities of principal occurrence are in Skagit, King, Kittitas, Stevens, and Mason counties, while bog ore is found in Whatcom, Clallam, Spokane, Whitman, Thurston, and Jefferson counties.[1] Galena is about the only lead ore found in the state and it occurs chiefly in association with other sulphides, as does also zinc, which is found in small quantities in the form of sphalerite or zinc-blende.[2]

The occurrence of platinum has been reported, but the deposits have not been sufficiently rich to place the extraction of this metal on a paying basis. Nickel ore is said to exist in Ferry county, and deposits of tungsten are found in some parts of the state, but no mines have been developed. Petroleum is obtainable in many of the coal regions, but has not been produced in commercial quantities.

One hundred and fifty-one operators in the state of Washington reported a total expenditure of $1,022,397 for development without production during 1902. This amount includes salaries and wages, miscellaneous expenses, cost of supplies and materials, and contract work, and represents an outlay greater than one-fifth of the total expenditures reported by the 90 producing mines and quarries in the state. Of the 151 mines reporting development work, 143 were gold and silver mines with expenses amounting to $989,812, or 96.8 per cent of the total disbursements for this purpose.

Mineral products form a basis for manufacturing industries to a large extent, being used as raw or partially manufactured material. The following table shows the extent to which the manufacture or remanufacture of mine and quarry products into manufactured products prevails in the state of Washington:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$86,795,061
Based upon products of mines or quarries:		
Chemicals and allied products	$69,400	
Clay, glass, and stone products	1,056,645	
Iron and steel and their products	2,592,946	
Metals and metal products, other than iron and steel	4,867,672	
Miscellaneous industries	5,562,302	
		14,148,965
All other		72,646,096

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[1] Washington Geological Survey, Vol. 1, pages 224 to 227.

[2] Ibid., pages 40 and 41.

As shown by the above table the products of those manufactures bearing intimate relation to mining or quarrying represent 16.3 per cent, or almost one-sixth of the total value of the products of all manufacturing industries in the state.

The total mine and quarry production during 1902 was valued at $5,393,659, or 5.8 per cent of the combined products of manufactures in 1900 and mines and quarries in 1902.

During 1900 there were employed in all branches of manufactures in the state 33,806 wage-earners who were paid $19,106,873 in wages. In 1902 there were employed in the mines and quarries of the state 4,567 wage-earners who received $3,735,484 in wages. Comparing the figures for these two branches of industry, it is seen that 88.1 per cent of the wage-earners, receiving 83.6 per cent of the wages, were employed in manufacturing establishments, while 11.9 per cent of the wage-earners, receiving 16.4 per cent of the wages, were employed in the mines and quarries of the state.

The following table, compiled from reports of the United States Geological Survey, shows the value of the annual production of the principal minerals from 1890 to 1902:

TABLE 3.—VALUE OF ANNUAL PRODUCTION OF PRINCIPAL MINERALS: 1890 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Silver.[1]	Gold.[1]	Limestones and dolomites.	Siliceous crystalline rocks.	Marble.	Sandstones and quartzites.
1890	$3,426,590	$90,506	$201,000	$231,287	(2)	(3)	$75,936
1891	2,437,270	213,334	335,000	25,000	(2)	(3)	75,000
1892	2,763,547	214,238	373,561	100,000	(2)	(3)	75,000
1893	2,920,876	197,430	222,100	139,862	(2)	(3)	15,000
1894	2,578,441	12,520	232,761	59,148	(2)	(3)	6,611
1895	2,677,958	158,640	351,000	75,910	(2)	(3)	14,777
1896	2,396,078	355,426	405,700	83,742	(2)	(3)	11,090
1897	2,777,687	138,214	419,900	126,877	55,800	(3)	16,187
1898	3,352,798	328,921	766,200	110,239	9,700	83,600	15,575
1899	3,603,989	330,990	685,400	139,339	42,766	4,837	58,395
1900	4,700,068	[4]139,190	718,200	249,163	48,900	11,836	68,133
1901	4,271,076	[4]206,640	580,500	234,587	43,808	22,816	99,174
1902	4,572,295	[4]328,070	272,200	213,814	147,273	61,176	30,725

[1] Estimates of the Director of the Mint, the values being for the refined product; silver at coining value. The values in Table 1 are the values at the mine.
[2] Not reported separately.
[3] Not reported.
[4] Commercial value.

There has been a noticeable growth in the mining industry during the last decade. With the construction of railways into mining and quarrying districts, more extensive development of the mineral resources of the state should speedily follow. Metalliferous deposits occur in many parts of the state,[1] the sulphide ores appearing in greatest abundance. Arsenides and antimonites are also found, but oxides and carbonates are somewhat less plentiful. The value of the nonmetallic mineral product during 1902 greatly exceeded that of the metallic, because of the extensive operations in coal mining and stone quarrying.

Coal, bituminous.—The first discovery of coal[2] was in the Cowlitz valley during 1848, but the quality was inferior. The occurrence of coal on the Stilaguamish river[3] was known as early as 1851, and deposits near Bellingham bay were discovered in 1852. In the following year the Sehome coal deposit, and that on the Black river not far from Seattle, were opened. In 1863 coal was discovered at Gilman and also near Lake Washington, and at a later date the Green river and other coal fields were found.

The character of the coal produced is chiefly lignite, although it often ranges to a bituminous or a semi-bituminous variety. Washington is the only one of the Pacific states in which coal of a coking quality has been mined, all the coal produced thus far in California and Oregon having been lignite.

The principal coal fields of the state are located in Kittitas, King, Pierce, Skagit, Whatcom, and Lewis counties in the order named, and important outcroppings have been noted in Lincoln, Spokane, Thurston, and other counties. The production increased phenomenally from 145,015 short tons, valued at $389,046, in 1880, to 1,263,689 short tons, with a value of $3,426,590, in 1890, an increase of 771.4 per cent in the quantity and 780.8 per cent in value. During the period of twelve years from 1890 to 1902 the increase in quantity was 112.2 per cent, and in value 33.4 per cent.

In 1902 the state ranked fifteenth in the United States in coal production, the total value of the product reported in that year being over $4,500,000. Table 4, compiled from reports of the United States Geological Survey, shows the annual production of coal from 1870 to 1902.

TABLE 4.—*Annual production of coal, bituminous: 1870 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1870	17,844	1881	167,554	1892	1,213,427
1871	20,000	1882	177,340	1893	1,264,877
1872	23,000	1883	244,990	1894	1,106,470
1873	28,000	1884	166,930	1895	1,191,410
1874	30,352	1885	380,250	1896	1,195,504
1875	99,568	1886	423,525	1897	1,434,112
1876	110,342	1887	772,601	1898	1,884,571
1877	120,896	1888	1,215,750	1899	2,029,881
1878	131,690	1889	1,030,578	1900	2,474,093
1879	142,666	1890	1,263,689	1901	2,578,217
1880	144,315	1891	1,056,249	1902	2,681,214

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[1] Washington Geological Survey, page 39.
[2] History of the Pacific States, by Hubert H. Bancroft, Vol. XXVI, page 340.
[3] Washington Geological Survey, page 257 ff.

The economic importance of coal mining to the state is illustrated by the fact that in 1902 the 3,931 wage-earners employed received $3,220,263 in wages, a sum equal to 16.9 per cent of the wages paid to all the wage-earners in the manufacturing industries in the state in 1900. Of all the industries reported in the census of manufactures in 1900, only the lumber and timber industry paid a larger sum to wage-earners than the amount reported by coal mining in 1902.

Gold and silver.—The discovery of gold[1] in 1848 did much to attract settlers to Washington. Gold is commonly found in the state associated with iron pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena,[2] the localities of occurrence being chiefly in Chelan, Ferry, Kittitas, Okanogan, Snohomish, Spokane, Stevens, Wallawalla, and Whitman counties.

Silver ores, principally galena,[3] pyrite, and ruby silver in slate, are widespread in their occurrence, being often found in the same veins with gold and copper. In Cedar canyon[2] and some other districts, native silver is also found.

The following table, compiled from reports of the Director of the Mint, shows the annual production of gold and silver from 1891 to 1902:

TABLE 5.—*Annual production of gold and silver, 1891 to 1902.*

[Reports of the Director of the Mint.]

YEAR.	Gold (fine ounces).	Silver (fine ounces).	YEAR.	Gold (fine ounces).	Silver (fine ounces).
1891	16,206	165,000	1897	20,312	106,900
1892	18,071	165,700	1898	37,065	254,400
1893	10,714	152,700	1899	33,156	256,000
1894	11,260	9,683	1900	34,743	224,500
1895	16,980	122,700	1901	28,062	314,400
1896	19,025	271,900	1902	13,166	619,000

As shown by Table 5, the production of precious metals in Washington has fluctuated considerably during the last decade. Extensive development operations during 1902 indicate an unusual interest in the many gold and silver deposits of the state.

Limestones and dolomites.—Extensive deposits of limestone are found in many parts of the state, but thus far only those in the vicinity of large towns or along railroads or boat lines have been developed. Limestone production is third among the important mineral industries of Washington, and the principal quarrying localities are in the northern and northwestern parts of the state.

The limestone quarried in the state has been utilized chiefly in lime burning, and has never been used to any considerable extent as a building material. The production has decreased during the last three years.

Siliceous crystalline rocks.—The siliceous crystalline rocks were second to limestone among the quarry products of the state in 1902, with a product valued at $147,273, or 32.5 per cent of the entire stone production of the state. The principal quarrying localities of this class of rocks are in the region adjacent to Puget sound, although considerable activity was reported in the extreme eastern portion of the state.

A large increase in production is shown for 1902, the value being more than that for the four previous years combined. This increase was principally in riprap and rubble, although the reports showed a gain in the use of siliceous crystalline rocks for all purposes.

Marble.—The marble quarried in Washington is of a serpentinous character, and is found principally in the eastern part of the state in Adams and Stevens counties. It is necessarily extracted in small blocks on account of its seamed markings. The production in 1902 was largely utilized for building purposes and interior decorations.

There was a large increase in the production of 1902 over former years, especially in the output of rough and building marble.

Sandstones and quartzites.—The principal occurrences of sandstones in Washington are found in the extreme northwestern part of the state in San Juan and Whatcom counties, and the production has decreased materially as compared with previous years.

All other minerals.—Clay deposits occurring chiefly as glacial clays, residual clays, and clay shales are found, and a small production was reported from the northeastern part of the state, but no extensive mining of these was done during the year.

The prevailing mineralogical character of the copper ore mined in this state is copper glance passing into chalcopyrite, and it is found in fissure veins with granite. The state's production in 1902 was confined to the output of one establishment.

The utilization of molybdenum in the preparation of steel has caused an increased demand for this mineral. It is also used in the manufacture of chemical reagents, principally ammonium molybdate, and in the preparation of "blue carmine" for porcelain coloring.[4] The molybdenite in this state occurs in association with gold, silver, and copper ore, and all the production was reported by one company.

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[1] History of the Pacific States, Vol. XXVI, pages 230 and 343.

[2] Washington Geological Survey, Vol. I, pages 39 and 40.

[3] The Mineral Industry, 1901, Vol. X, page 302.

[4] United States Geological Survey, "Mineral Resources of the United States," 1901, pages 266 and 267.

WEST VIRGINIA.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells in the state of West Virginia for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Petroleum.	Natural gas.	Limestones and dolomites.	Sandstones and quartzites.	All other minerals.[1]
Number of mines, quarries, and wells	14,874	522	13,109	949	174	110	10
Number of operators	5,192	406	4,446	63	[illegible]	100	10
Salaried officials, clerks, etc.:							
Number	2,614	1,987	328	221	31	38	9
Salaries	$2,443,150	$1,766,148	$399,207	$225,501	$27,259	$18,965	$5,770
Wage-earners:							
Average number	30,002	23,914	3,800	634	1,068	453	133
Wages	$17,469,826	$13,524,429	$2,773,312	$410,845	$426,401	$272,123	$62,716
Contract work	$5,194,279	$23,092	$4,176,647	$994,540			
Miscellaneous expenses	$7,468,316	$2,067,528	$4,523,499	$822,639	$8,144	$17,533	$9,003
Cost of supplies and materials	$8,519,767	$2,327,377	$4,564,908	$1,495,069	$78,146	$28,500	$25,767
Value of product	$48,378,414	$21,748,658	$17,040,317	$5,390,181	$616,366	$423,532	$159,360

[1] Includes operators as follows: Cement, 1; clay, 4; grindstones and pulpstones, 2; iron ore, 1; silica sand, 2.

The extensive coal deposits in the state are almost inexhaustible, coal being found in all but three counties, and the annual production has steadily increased until in 1902 West Virginia ranked fourth among the coal producing states. The oil production is large and the state has within its borders the largest single producing oil field in the world. Natural gas wells are numerous and productive. Most excellent building stones abound throughout the state, and the white sand near Berkeley Springs, in Morgan county, is of exceptional purity. In several places in the state good grits are found for making grindstones. One of the most widespread of all the natural resources of the state is its clay. Iron ore is known to abound in many counties.[1] The manufacture of natural rock cement has been going on for many years.[2]

The following minerals found in the state were not mined or quarried in commercial quantities in 1902: Grahamite, manganese ore, and strontium ore. The celebrated grahamite deposits of Ritchie county, although once mined extensively, have been abandoned for over twenty-five years.[3]

In addition to the active mines, quarries, and wells shown in the foregoing table, development work, confined to bituminous coal, natural gas, and silica sand was reported by 13 operators in 28 mines, quarries, and wells; these gave employment during 1902 to 51 wage-earners, and paid $26,645 in wages. The 14 salaried officials, clerks, etc., received $7,731. The cost of work done by contract was $45,315; the miscellaneous expenses were $6,303, and the cost of supplies and materials amounted to $73,437.

Table 2 shows the value of the products of manufactures, based primarily upon minerals mined and quarried, and also the value of all products manufactured in the state as reported at the census of 1900.

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$74,638,330
Based upon products of mines or quarries:		
Chemicals and allied products	$827,560	
Clay, glass, and stone products	3,934,849	
Iron and steel and their products	20,407,336	
Metals and metal products, other than iron and steel	760,433	
Miscellaneous industries	5,015,645	
		30,945,823
All other		43,692,507

The value of the manufactured products, based primarily upon minerals mined and quarried, was $30,945,823, or 41.4 per cent of the total for all manufactures, as shown in the foregoing table. The total value of products of mines, quarries, and wells of West Virginia in 1902 and manufactures in 1900 amounted to

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[1] The Mountain State, by George W. Summers, page 41.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 809.

[3] Ibid., Twenty-second Annual Report, 1900–1901, Part I, page 233.

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$123,216,744. Of this amount, manufactures contributed 60.7 per cent, and mines and quarries 39.3 per cent.

In 1900, according to the Twelfth Census reports, 33,272 wage-earners were employed in manufacturing, and the wages paid them during the same year amounted to $12,969,237. The operators of the 14,874 productive mines, quarries, and wells in 1902 employed 30,002 wage-earners, and paid them $17,469,826 in wages. Manufactures and mining together gave employment during the year to 63,274 wage-earners, and paid $30,439,063 in wages. Manufactures, therefore, gave employment to 52.6 per cent of the wage-earners, and paid 42.6 per cent of the wages, while mines, quarries, and wells furnished employment to 47.4 per cent of the wage-earners, and paid 57.4 per cent of the wages.

The following table shows the value of the annual production of the leading minerals of the state from 1890 to 1902:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Petroleum.	Natural gas.	Limestones and dolomites.	Sandstones and quartzites.
1890	$6,208,128	$501,198	$5,400	$93,856	$140,687
1891	7,359,816	1,612,826	35,000	85,000	90,000
1892	7,852,114	2,119,901	500	85,000	85,000
1893	8,251,170	5,425,522	123,000	19,184	46,135
1894	8,706,808	7,221,717	395,000	43,775	63,865
1895	7,710,575	11,038,770	100,000	42,892	40,000
1896	8,336,685	11,829,018	640,000	59,113	21,693
1897	8,987,393	10,310,178	912,528	61,546	47,288
1898	10,131,264	12,426,359	1,334,023	56,167	14,381
1899	12,053,268	18,014,766	2,335,864	58,802	33,860
1900	18,416,871	21,922,702	2,959,032	63,701	72,438
1901	20,848,184	17,172,724	8,954,472	447,049	103,010
1902	24,748,658	17,040,317	6,390,181	616,366	123,532

Coal.—The coal deposits of West Virginia, underlying some 17,280 square miles of the state's area,[1] belong to the great Appalachian coal field, and have almost the largest expanse of continuous coal measures in the world.[2] In all but 4 of the 55 counties of the state bituminous coal has been found.[3]

The advantages of the state in coal production lie in the facts that a great number of the seams found are accessible above water level, and that the coals are of various compositions adapted to the requirements of trade. The fat coking, gassy bituminous, the hard and valuable splint, and the rich and oily cannel coal are found in great purity and made easily accessible through the agency of running water, which has exposed the seams in thousands of places. This fact, added to their size, permits, as a general rule, the mining of coal in West Virginia to be carried on at less cost, and with more economy, under corresponding labor rates, than is possible in any other part of the Allegheny coal fields.[4]

The presence of coal in West Virginia was known to the earliest settlers, and shipments were made from the Cumberland-Piedmont district of Maryland and West Virginia as early as 1842, but until 1855 all the shipments were from Maryland.[5] In 1863 a few small coal mines produced some coal for domestic consumption,[6] and in 1864 the first splint coal was mined at Coalburg, in Kanawha county.[7] During the past twenty-three years the increase in the coal production of West Virginia has averaged 1,000,000 tons a year.

The principal coal producing regions of the state may be divided into four districts, which include the more important coal producing counties. These during 1902 produced nearly 90 per cent of the output of the state. The two northern districts are known as the Fairmont, or Upper Monongahela district, and the Elk Garden, or Upper Potomac district. The two southern districts are the Pocahontas, or Flat Top district, and the New and Kanawha river district. The most important district from the productive point of view is the New and Kanawha river district, which includes the counties of Fayette, Kanawha, Raleigh, and Putnam.[8]

In 1902 coal was mined in 29 counties, among which McDowell ranked first with a production of 5,459,655 tons, Fayette second with 4,775,112 tons, and Marion third with 3,397,194 tons. The total production in 1902 was 24,570,826 tons, an increase of 502,424 tons over 1901. The greatest increase was shown in McDowell county. Fayette county showed a decrease of 1,277,277 tons, due to the strikes in 1902.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of coal in West Virginia from 1863 to 1902:

TABLE 4.—*Annual production of coal, bituminous: 1863 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons	YEAR.	Short tons	YEAR.	Short tons.
1863	41,648	1877	1,120,000	1890	7,394,654
1864	54,888	1878	1,120,000	1891	9,220,665
1865	87,987	1879	1,400,000	1892	9,738,755
1866	112,068	1880	1,568,000	1893	10,708,578
1867	89,360	1881	1,680,000	1894	11,627,757
1868	109,227	1882	2,240,000	1895	11,387,961
1869	104,148	1883	2,335,833	1896	12,876,296
1870	75,138	1884	3,360,000	1897	14,248,159
1871	118,830	1885	3,369,062	1898	16,700,999
1872	149,521	1886	4,005,796	1899	19,252,995
1873	672,000	1887	4,881,620	1900	22,647,207
1874	1,120,000	1888	5,498,800	1901	24,068,402
1875	1,120,000	1889	6,231,880	1902	24,570,826
1876	896,000				

Petroleum.—At an early date petroleum in small quantities was found in West Virginia, and as far back as 1771 Thomas Jefferson described a burning spring, and the oil connected therewith, located in the Kanawha valley.[1] Prior to the Civil War the discovery of oil in shallow wells near Parkersburg, in the Burning Springs region in the Little Kanawha valley, caused the most intense excitement, scarcely equaled by that in California over the discovery of gold. Towns sprang into existence, derricks were erected, and oil wells were bored, but the war broke up the oil excitement, the derricks and machinery were destroyed, and for a time, the business was at a standstill.[2] After the close of the Civil War, in 1865, interest in the petroleum in the state was revived and the industry instead of being entirely speculative was put on a legitimate business basis. As a consequence oil development became more scientific and operations were commenced almost simultaneously at Burning Springs, Oil Rock, California House, Volcano, Sandhill, and Horseneck. It is estimated that before 1876 not less than 3,000,000 barrels, valued at $20,000,000, had been produced in these districts.[3]

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 293.

[2] Resources of West Virginia, by Maury and Fontaine, page 162.

[3] The Mountain State, page 11.

[4] Resources of West Virginia, page 215.

[5] United States Geological Survey, "Mineral Resources of the United States," 1902, page 305.

[6] Report of the Commissioner of Labor of West Virginia, 1897–98, page 116.

[7] Transactions of the American Institute of Mining Engineers, Vol. X, page 82.

[8] United States Geological Survey, "Mineral Resources of the United States," 1902, page 442.

The following table, compiled from the reports of the United States Geological Survey, shows the annual production of petroleum in West Virginia from 1876 to 1902:

TABLE 5.—*Annual production of petroleum: 1876 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States"]

YEAR.	Barrels.	YEAR.	Barrels.
Total	131,701,296	1888	119,448
		1889	544,113
Previous to 1876	3,000,000	1890	492,578
1876	120,000	1891	2,406,218
1877	172,000	1892	3,810,086
1878	180,000	1893	8,445,412
1879	180,000	1894	8,577,624
1880	179,000	1895	8,120,125
1881	151,000	1896	10,019,770
1882	128,000	1897	13,090,045
1883	126,000	1898	13,615,101
1884	90,000	1899	13,910,630
1885	91,000	1900	16,195,675
1886	102,000	1901	14,177,126
1887	145,000	1902	13,513,345

The modern development of the oil interests of the state dates from 1889. That year marked the opening of the Dolls Run, Eureka, and Mannington oil pools,[4] and from that time until 1900 there was an almost steady increase in the production. In 1900 the output of the oil wells of the state was 16,195,675 barrels.

Although oil had been developed in Pennsylvania long before 1865, it was in West Virginia that the means of transporting it to market in the manner now recognized to be cheap, safe, and expeditious, were first furnished.[5]

In 1902 the production of petroleum in West Virginia amounted to 13,513,345 barrels, a decrease of 663,781 barrels from the product of the preceding year. The 1902 output was valued at $17,040,317. The state ranked second among the oil producing states and territories in 1902, producing 15.1 per cent of the entire output of the United States.

Natural gas.—It is quite probable that the burning springs of West Virginia had attracted the attention of the Indians long before the advent of the white man in this region. One of the earliest records of these natural gas vents was made by George Washington in 1775, when he described a "burning spring" on the Kanawha river, 9 miles above Charleston. This was preempted along with other lands and given to him for military services by the state of Virginia, and he deeded it, together with a square acre of ground, to the public.[6]

The first natural gas field to be developed and put into practical use was that near Wellsburg, Brooke county. Natural gas was first used for manufacturing purposes in West Virginia in the Kanawha valley thirty years before it was used for that purpose in Pennsylvania.[7]

In 1902 West Virginia ranked third among the states in the production of natural gas. Large areas in Lewis, Harrison, Marion, Monongalia, and Wetzel counties were discovered and developed between 1900 and 1902. More or less natural gas has been developed in Tyler, Ritchie, Doddridge, Marshall, Wood, Wirt, Roane, Calhoun, Boone, Mingo, Kanawha, Logan, and Gilmer counties.[8]

Since 1895 there has been a notable yearly increase in production of natural gas. In 1902 the value of the production was $5,390,181, an increase of $1,435,709, or 36.3 per cent as compared with 1901.

Limestones and dolomites.—The value of the output of the 174 quarries productive in 1902 amounted to $616,366, an increase of $169,317 over the product of 1901. Jefferson county ranked first among the 11 counties in value of product, but Preston county ranked first in number of quarries. The value of the blast furnace flux produced in the state in 1902 was $268,059, or 43.5 per cent of the value of all limestone.

Sandstones and quartzites.—Among the beds of the conglomerate coal measures, sandstones of almost any size and texture can be quarried. In Monongalia county a beautiful sandstone, of a light buff and dove color, is found which can be dressed readily, and is most suitable for building purposes. In Taylor county occurs the so-called Grafton sandstone of close texture, sharp and clean grit, and gray color. The gray sandstone of Lewis county has few, if any, superiors in the United States in architectural beauty. The sandstones of the Lower Coal Measures on the upper portion of the Kanawha river have furnished materials for locks and dams built by the Government.[9]

Only 10 of the 110 quarries productive in 1902 had an output valued at more than $10,000. The value of the sandstones quarried in the state in 1902 was $423,532, an increase of $320,522 over the value for 1901. Mercer ranked first among the counties in the state in the value of its sandstones quarried in 1902.

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[1] Resources of West Virginia, page 305.

[2] The Mountain State, page 77.

[3] Resources of West Virginia, pages 306 and 307.

[4] West Virginia Geological Survey, 1899, Vol. I, pages 148 to 150.

[5] Resources of West Virginia, page 308.

[6] West Virginia Geological Survey, 1899, Vol. I, page 124.

[7] The Mountain State, pages 77 and 78.

[8] United States Geological Survey, "Mineral Resources of the United States," 1902, page 643.

[9] Resources of West Virginia, pages 315 and 316.

All other minerals.—Natural rock cement was made near Shepherdstown, Jefferson county, as early as 1825.[1] The industry was not followed continuously in this locality, but about 1870 a new plant was erected, and for more than thirty years a superior brand of natural rock cement was produced.[2] A single plant reported production during 1902.

Quantities of good potter's and fire clay are found in the state, and in 1902 West Virginia ranked fourth among the states in the value of its pottery products, which amounted to $1,166,464, and ninth in the value of all its products of clay, which reached $2,518,544. The value of the clay production of the state was $43,266.

Good grits for grindstones are found in many counties in the state, and a part of the well-known ledge of stone appearing in Ohio across the river from Parkersburg is found in Wood county.[3] In 1902 Jackson and Wood were the only counties from which grindstones were reported; the value was $22,347.

Iron ore is found in the coal hills, the best being around Laurel hills and at Beaver Lick mountain; but the enormous beds of ore in the state have been as yet only slightly developed.[4] At various times, before and since the organization of the state, iron has been made from West Virginia ores, which, in every instance, produced iron of an excellent quality.[5] Only one iron mine was operated in the state in 1902.

Near Berkeley Springs, in Morgan county, is a ridge of sandstone, which, when crushed, yields a beautiful white sand of exceptional purity. It is about the best sand found in the United States, and large quantities of it have been shipped for glassmaking.[5] Sand for other uses is obtained in Marion, Hampshire, Randolph, and Monongalia counties.[6] The output of sand in the state for 1902 was 107,520 short tons, of which 74,720 tons were glass sand. The value of all sand was $121,540, while that of the glass sand was $99,340.

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[1] Resources of West Virginia, page 313.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, page 809.

[3] The Mountain State, page 91.

[4] King's Handbook of the United States, page 883.

[5] The Mountain State, page 41.

[6] United States Geological Survey, "Mineral Resources of the United States," 1902, page 1011.

WISCONSIN.

Table 1 is a summary of the statistics for the productive mines and quarries in the state of Wisconsin for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Iron ore.	Limestones and dolomites.	Lead and zinc ore.	Siliceous crystalline rocks.	Sandstones and quartzites.	All other minerals.[1]
Number of mines or quarries	411	16	216	90	18	62	9
Number of operators	392	10	207	90	15	62	8
Salaried officials, clerks, etc.:							
Number	275	83	82	50	30	13	17
Salaries	$232,758	$85,262	$58,353	$26,202	$31,284	$9,129	$22,528
Wage-earners:							
Average number	3,583	1,361	1,062	417	391	199	153
Wages	$1,987,565	$837,661	$539,169	$192,209	$236,495	$109,066	$72,965
Contract work	$3,758	$2,750		$1,008			
Miscellaneous expenses	$427,847	$247,149	$47,052	$54,534	$26,211	$3,632	$49,269
Cost of supplies and materials	$804,142	$375,959	$290,150	$56,774	$35,409	$17,169	$28,681
Value of product	$4,427,813	$1,800,864	$1,351,058	$473,652	$369,137	$207,086	$226,016

[1] Includes operators as follows: Cement, 2; clay, 3; copper ore, 1; graphite, 1 (2 mines); mineral pigments, crude, 1.

Wisconsin has valuable iron ore deposits along the borders of Lake Superior in the north, the output of which is yearly increasing, as well as extensive lead and zinc ore mines which have been operated for many years in the Galena-Dubuque region in the southwestern part of the state. Large and valuable areas of building stones are found in many parts of the state, and along the shore of Lake Michigan there are large beds of clay. Flint also is found, but was not mined in commercial quantities in 1902.

The relative importance of manufacturing industries closely allied to or based upon the mining industry, using as their raw material the product of the mine or quarry, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$360,818,942
Based upon products of mines or quarries		
Chemicals and allied products	$1,135,963	
Clay, glass, and stone products	5,159,002	
Iron and steel and their products	36,300,640	
Metals and metal products, other than iron and steel	6,066,982	
Miscellaneous industries	11,808,224	
		60,470,851
All other		300,348,091

The total value of the products of manufactures, based primarily upon minerals mined or quarried, was $60,470,851, or 16.8 per cent of the value of all manufactured products. The value of the output of the mines and quarries in Wisconsin in 1902 was $4,427,813, or 1.2 per cent of the total value of the product of manufacturing and mining industries of the state.

The average number of wage-earners employed in manufacturing establishments in 1900 was 142,076, and the total wages paid amounted to $58,407,597. The corresponding figures for the mines and quarries of Wisconsin in 1902 were 3,583 wage-earners and $1,987,565 paid in wages. It appears that of the number of wage-earners engaged in the two industries during the year, 98 per cent were employed in manufacturing establishments and received 97 per cent of the wages, while 2 per cent of the wage-earners were engaged in mining and were paid 3 per cent of the wages.

The following table shows, for the years from 1890 to 1902, the value of the annual production of the principal minerals, with the exception of lead and zinc for which values can not be obtained:

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Iron ore.	Limestones and dolomites.	Siliceous crystalline rocks.	Sandstones and quartzites.
1890	(1)	$813,963	$266,095	$183,968
1891	(1)	675,000	406,000	417,000
1892	$1,428,921	675,000	400,000	400,000
1893	584,094	543,283	133,220	92,198
1894	320,518	798,406	166,098	94,888
1895	633,165	750,000	80,761	78,000
1896	1,071,511	552,921	126,639	65,017
1897	703,770	641,232	126,134	33,020
1898	687,913	696,454	175,987	80,341
1899	837,766	828,186	270,538	132,901
1900	2,081,272	989,685	407,711	81,571
1901	1,564,173	1,225,448	389,953	90,425
1902	1,800,864	1,351,058	369,137	207,086

[1] Value not reported.

Iron ore.—Although the existence of iron ore, similar to the Michigan ore, occurring in Wisconsin along Lake Superior, was known early in the last century, nothing of any consequence was done toward developing the deposits until about 1877, when work was begun in Florence county, and in 1882, 276,017 tons were shipped from that county. The greatest development of the iron ore resources of the state has occurred since 1884 in the Gogebic district in Ashland and Iron counties.[1] Iron ore of the red hematite variety from the Iron Ridge, in Dodge county, was probably mined to some extent as early as 1854, reference being made in that year to its quality and abundance.[2] In 1902 the state produced 783,996 long tons. The greatest amount was mined in Iron county, which produced about 79 per cent of the total. The production in the state from 1889 to 1902 is shown in the following table:

TABLE 4.—*Annual production of iron ore: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Long tons.	YEAR.	Long tons.
1889	837,399	1896	667,405
1890	948,965	1897	654,155
1891	609,481	1898	599,645
1892	790,179	1899	679,798
1893	439,429	1900	746,108
1894	347,501	1901	738,868
1895	649,351	1902	783,996

Limestones and dolomites.—Limestone underlies a large part of Wisconsin, the beds extending in a broad belt through the eastern, southern, and western portions of the state. The suitability of the stone for building purposes varies greatly, not only in the different formations, but also in the different beds of the same formation, and the color of the stone ranges from buff, or straw-yellow, to dark bluish gray.[3]

The earliest recorded quarry in the state was opened at Genesee, Waukesha county, in 1848, and this quarry was operated continuously until 1872, since which time it has been worked only at intervals. The Wauwatosa quarries, near Milwaukee, were opened in 1855, and one year later the quarry near Bridgeport was opened.[4] Previous to 1880, however, with a single exception, no product of the quarries had been exported from the state.[5]

Wisconsin ranked seventh in 1902 among the limestone producing states. The value of its production was $1,351,058, of which $296,998 was the value of the building stone, which comes principally from the quarries in Brown, Door, Milwaukee, Rock, and Waukesha counties. The largest quarries were in Calumet, Door, Fond du Lac, Manitowoc, Racine, and Waukesha counties.

Lead and zinc ore.—The lead mines of the upper Mississippi valley district, comprising Grant, Lafayette, and Iowa counties in Wisconsin; Jo Daviess county in Illinois; and Dubuque county in Iowa, seem to have been discovered by Nicholas Perrott about 1692. This metal was also noticed by Le Sueur in 1700, and by John Carver in 1766. The first mining in this district was done by Julien Dubuque in 1788 on the site of the present city of Dubuque, Iowa, but it was not until about 1830 that lead mining became general in southwestern Wisconsin. From that time until to-day mining has been continuous in the state.[6] About 1860 zinc ore was first mined, the earlier work having been entirely devoted to lead mining; now, however, this district has become more important as a source of supply of zinc than of lead ore. The ores mined are galena, smithsonite, and sphalerite, the latter being the most important.[6]

In 1902 the total production of lead and zinc ore in Wisconsin amounted to 21,999 short tons, having a value of $473,652. Of this production only 2,623 tons were lead ores. Lafayette county had a production of 9,156 short tons, the greater part of which was sphalerite. Of the 90 mines operated in 1902, 27 mined lead ore only, 23 mined zinc ore only, and 40 mined both lead and zinc ore.

Siliceous crystalline rocks.—Although about one-third of the entire area of Wisconsin is underlaid by the older siliceous crystalline rocks, it has been within the last twenty-five years only that the quarrying of granite has assumed any considerable importance, and even now the annual output is insignificant when compared with that of many other states.[7] For monumental purposes the Wisconsin granites have been selected in preference to granites from other parts of the country, and for structural purposes the quarries can furnish either gray or red granite of any required dimension. For road construction probably no state in the Union is better provided with material. The granites vary in texture from exceedingly fine grained to the coarse grained porphyritic variety, and in color from a brilliant red to a dark gray. The first granite quarry was opened at Granite Heights in Marathon county in 1880.[8] Near Utley, in Green Lake county, there occurs a beautiful stone, almost black in color, with white porphyritic feldspar, which has been quarried to some extent; and near Berlin, in the same county, occur two mounds of compact, dense grayish black to pinkish quartz porphyry or rhyolite, which takes a high polish and seems to be eminently adapted for monumental work.[9]

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[1] Iron in All Ages, by James M. Swank, pages 329 and 330.

[2] Metallic Wealth of the United States, by J. D. Whitney, page 482.

[3] Wisconsin Geological and Natural History Survey, Bulletin No. IV, pages 255 and 256.

[4] Ibid., pages 300 and 313.

[5] Stones for Building and Decoration, by George P. Merrill, page 323.

[6] Wisconsin Geological and Natural History Survey, Bulletin No. IX, pages 1 and 2.

[7] Stones for Building and Decoration, pages 87 and 98.

[8] Wisconsin Geological and Natural History Survey, Bulletin No. IV, pages 89, 90, and 132.

[9] Stones for Building and Decoration, pages 167 and 168.

The 18 quarries operating in 1902 were located in Dodge, Green Lake, Marathon, Marinette, Marquette, Sauk, Waupaca, and Waushara counties, and their output was valued at $369,137.

Sandstones and quartzites.—One of the most widely distributed building stones, and one which furnishes perhaps the greatest variety in color and texture among the sedimentary rocks, is the sandstone of the Potsdam and St. Peter's formation. The Potsdam appears first in the northeast corner of the state and swings in a broad belt around to the southwest and then again northwest. A second smaller belt skirts the south shore of Lake Superior entirely across the state in an east and west direction. The stone from this belt, on account of its color, is commonly known as the Lake Superior brownstone, and was first quarried in 1868 on Bass Island. This stone was quarried in the counties of Ashland, Bayfield, and Douglas, and has been used for structural purposes in many states.[1] The stone quarried from the southern Potsdam area is mostly used locally, the color, texture, durability, and composition of the stone varying greatly in the different beds. The so-called St. Peter's sandstone is found in a comparatively narrow strip extending from the Menominee river, in the northeastern part of the state, south as far as the state line, thence west to the Mississippi river. The stone is brown, red, yellow, or nearly white in color, and as a rule is coarse and rather friable.[2]

Based on the value of product, Sauk ranked first among the sandstone producing counties of Wisconsin, Dunn county second, and Bayfield third. Only 6 of the 23 counties in which sandstone is quarried had a value of output in excess of $10,000. The value of the sandstone quarried in the state in 1902 was $207,086.

All other minerals.—In 1875, at Whitefish Bay, Milwaukee county, the first cement mill in the state was erected, and with scarcely any interruption this plant has been a steady producer of an excellent quality of natural rock cement. A second plant was erected near the first in 1890. Based on the value of the production, Wisconsin ranked fourth among states producing natural rock cement.

Stratified beds of clay, from which over 50,000,000 brick are made annually, are found along the shore of Lake Michigan. Although the clay usually is red the bricks are cream colored, and Milwaukee derives its name of "The Cream City" from the fact that this brick has been used so extensively in its buildings.[2] The value of the clay produced in Wisconsin in 1902 was $23,178, and the value of the brick and tile made from it was $1,014,373.[3]

There are copper ores in the zinc and lead district of southwestern Wisconsin, and some crude attempts at copper mining have been made. By far the most important recent development, however, has been in Douglas county, in the northern part of the state.[4]

Some graphite was produced in Portage county in 1902, and some metallic paints were made from a certain hematite iron ore found in Dodge county, but no figures can be shown for either of these minerals without disclosing individual operations.

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[1] Stones for Building and Decoration, pages 167 and 168.

[2] King's Handbook of the United States, page 894.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 726.

[4] The Copper Handbook, by Horace J. Stevens, Vol. III, page 118.

WYOMING.

Table 1 is a summary of the statistics for the productive mines, quarries, and wells of the state of Wyoming for 1902.

TABLE 1.—SUMMARY: 1902.

	Total.	Coal, bituminous.	Sandstones and quartzites.	Limestones and dolomites.	Gold and silver.	All other minerals.[1]
Number of mines, quarries, and wells	74	36	12	3	4	19
Number of operators	50	22	12	3	4	[illegible]
Salaried officials, clerks, etc.:						
Number	153	125	3		4	21
Salaries	$188,616	$159,153	$2,038		$3,245	$24,180
Wage-earners:						
Average number	4,486	4,197	74	7	25	183
Wages	$3,432,059	$3,207,545	$58,897	$5,640	$24,570	$135,407
Contract work	$15,547	$12,747			$300	$2,500
Miscellaneous expenses	$280,602	$221,947	$2,291	$2	$160	$53,202
Cost of supplies and materials	$818,496	$669,328	$4,337	$225	$11,139	$133,467
Value of product	$5,684,286	$5,236,339	$90,691	$6,340	$4,923	$345,993

[1] Includes operators as follows: Copper ore, 1; graphite (1 mine, operator reported in South Dakota); grindstones and pulpstones (operator reported under sandstones and quartzites); gypsum, 2 (3 quarries); iron ore, 1; petroleum, 2 (13 wells); precious stones, 3 (no mines).

Wyoming is excelled by few states in the variety and amount of its mineral resources.[1] Although greatly hindered in the development of its mines and quarries because of the lack of capital and means of transportation, its product in 1902 was valued at $5,684,286. In the value of its mineral products the state was twenty-seventh in rank; almost the entire mineral production was from its mines of coal, in the output of which mineral the state ranked fourteenth.

The rocks included in the group "sandstones and quartzites," occur in almost inexhaustible beds, and are equal to those of any other state in point of beauty and durability.[2]

Limestones and dolomites are of wide occurrence and were quarried to a limited extent in 1902.

Gold and silver mining, which was an important factor in the early development of the state, has decreased in importance, until in 1902 the product amounted to only $4,923.

Other minerals produced commercially in 1902 were copper ore, graphite, grindstones and pulpstones, gypsum, iron ore, petroleum, and precious stones.

Arsenic, asbestos, glass sand, granite, kaolin, and fire clay, magnesium, marble, mica, platinum, vein and stream tin, and volcanic ash are of known occurrence in the state, but were not mined on a commercial scale in 1902.[3]

Development work confined to gold and silver and petroleum was reported by 87 operators in 1902. They paid out $405,285 for salaries and wages, $86,204 for contract work, $35,120 for expenses of a miscellaneous character, and $140,754 for supplies and materials.

Certain manufacturing industries are closely allied to or based upon the mining industry, using as raw material the products of mines and quarries. The relative importance of these branches of manufacture, as indicated by the value of their products, is shown in the following table:

TABLE 2.—*Manufactures based primarily upon the products of mines and quarries: 1900.*

INDUSTRY.	Value of product.	
All manufactures		$4,301,240
Based upon products of mines or quarries:		
Clay, glass, and stone products	$43,675	
Iron and steel and their products	332,175	
Metals and metal products, other than iron and steel	43,102	
Miscellaneous industries	225,662	
		644,614
All other		3,656,626

The total value of product of these manufacturing industries based on mining was, as shown by Table 2, $644,614, or 15 per cent of the product of all manufactures in the state in 1900.

The number of wage-earners employed in manufactures in 1900 was 2,241, and they received $1,386,140 in wages. In 1902, 4,486 wage-earners were employed in mines and quarries, and they were paid $3,432,059 in wages. By combining the figures for these two branches of industry it is shown that mines and quarries furnished employment to 66.7 per cent of the wage-earners, and paid 71.2 per cent of the wages, while there were employed in manufactures 33.3 per cent of the wage-earners, who were paid 28.8 per cent of the wages.

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[1] The State of Wyoming, by Fenimore Chatterton, pages 9 and 13.

[2] Ibid., page 17.

[3] Ibid., page 13 ff.

Table 3, compiled from the reports of the United States Geological Survey, shows the value of the annual production of the principal minerals from 1890 to 1902.

TABLE 3.—*Value of annual production of principal minerals: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Coal, bituminous.	Sandstones and quartzites.	Gold and silver.[1]
1890	$3,183,669	$16,760	(²)
1891	3,555,275	25,000	(²)
1892	3,168,776	15,000	(²)
1893	3,290,904	100	(²)
1894	3,170,392	4,000	(²)
1895	2,977,901	10,000	(²)
1896	2,904,185	16,465	$14,429
1897	3,136,694	11,275	11,329
1898	3,664,190	6,382	5,429
1899	4,742,525	32,583	29,717
1900	5,457,953	27,671	[3] 34,324
1901	6,060,462	54,145	[3] 25,540
1902[4]	5,286,339	90,691	[3] 41,450

[1] Estimates of the Director of the Mint; values of the refined product; silver at coining value.

[2] Not reported separately.

[3] Silver at commercial value.

[4] Census figures, except for gold and silver.

Coal, bituminous.—The production of coal on a commercial scale in Wyoming began in 1869.[1] The first mine was opened at a point about 3 miles from Evanston, in Uinta county, soon after the construction of the transcontinental railway.

The coal fields of Wyoming cover an area of more than 20,000 square miles; they have been known since 1850, but remained undeveloped until 1868 because of the lack of transportation facilities and market.[2] Since that time coal mining has developed into the leading branch of mineral industry in the state, and the known area of coal deposits has been extended through successive discoveries until it includes every county in the state; some of the veins vary in thickness up to 75 feet. The most common variety is a pure lignite, though in certain localities a good coking coal is mined. In 1887 a semianthracite coal was discovered in Johnson county.[3]

The best grades are low in ash and sulphur, and are excellent for steam making, domestic purposes, and the manufacture of gas. During the early development of the industry, almost the entire product was sold to the railway companies,[4] but in later years their consumption has amounted approximately to one-third of the production.[5]

Table 4, compiled from reports of the United States Geological Survey, shows the annual production of coal, bituminous, from 1865 to 1902.

TABLE 4.—*Annual production of coal, bituminous: 1865 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Short tons.	YEAR.	Short tons.	YEAR.	Short tons.
1865	800	1878	333,200	1891	2,327,841
1866	2,500	1879	400,991	1892	2,503,839
1867	5,000	1880	527,811	1893	2,439,311
1868	6,925	1881	628,181	1894	2,417,463
1869	49,382	1882	707,764	1895	2,246,911
1870	105,295	1883	779,689	1896	2,229,624
1871	147,328	1884	902,620	1897	2,597,886
1872	221,745	1885	807,328	1898	2,863,812
1873	259,700	1886	829,355	1899	3,837,392
1874	219,061	1887	1,170,318	1900	4,014,602
1875	300,808	1888	1,481,540	1901	4,455,874
1876	334,550	1889	1,388,947	1902	4,429,491
1877	342,853	1890	1,870,366		

In 1902 the reports from 11 of the 13 counties showed the mining of coal. Sweetwater county ranked first, with a product of 1,595,340 tons, followed by Uinta, with 1,595,333; Carbon, with 382,207; and Converse, with 72,329 tons. The state's production in 1902 shows a decrease from that of 1901 of 55,883 tons, Carbon and Sweetwater counties showing the greatest loss. The statistics for Uinta county show an increase of 156,186 tons for the year.

Sandstones and quartzites.—A large amount of the product of the sandstone quarries in Carbon county is shipped to Colorado, Nebraska, and Utah. The capitol at Cheyenne and the state penitentiary were built of this stone. The Iron mountain quarries in Laramie county produce a white stone that is much used for building purposes. The Carnegie Library and Federal building at Cheyenne were constructed from this material.[6]

In 1902 sandstones and quartzites were quarried in Albany, Carbon, Crook, Laramie, and Uinta counties. Of the total production, $90,691, that sold for building purposes amounted to $40,451, and that for rubble to $10,096.

Limestones and dolomites.—There are several exposures of a thick limestone formation near Lava creek and in the valley of the East Fork of the Yellowstone river. Compact crystalline limestone also occurs near the summit of the Owl creek range of mountains, and in the Wind river range there are numerous strata resembling the Quebec and Niagara limestones.[7]

The only quarries reported in 1902 were in Albany county, and their product amounted to $6,340. Of this amount, $2,250 was the value of stone used for lime making and $4,000 the value used for blast furnace flux.

Gold and silver.—Though the Laramie trail, one of the principal highways to the Pacific coast, was traversed by many caravans of Mormons on their way to Deseret, Utah, and by thousands of prospectors going to the gold fields of California, the occurrence of gold in Wyoming was not discovered until 1867. In that year the placer mines on the Sweetwater river were found, and for several years produced rich results. Placer and quartz mines have been discovered in almost every county in the state.[1] The annual production of gold and silver in the state since 1867 has ranged in value from $25,000 to $125,000.[2]

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[1] Harper's Encyclopedia, Vol. 9, page 564.

[2] United States Geological Survey, "Mineral Resources of the United States," 1883, page 100.

[3] The State of Wyoming, page 14.

[4] King's Handbook of the United States, pages 906 and 907.

[5] Proceedings of the Wyoming Industrial Convention, 1901, page 86.

[6] The State of Wyoming, page 17.

[7] Reconnaissance of Wyoming, by William A. Jones, pages 111 and 112.

All other minerals.—Copper, in the form of glance, pyrites, silicate, green carbonate, and red oxide, occurs in Laramie, Carbon, Albany, and Crook counties.[3]

Veins of graphite occur at French creek, Plumbago canyon, and Halleck canyon in Albany county, and in the Indian Grove mountains in Carbon county. The veins are large and easily accessible and contain from 40 to 60 per cent of carbon.[4]

The Triassic formation exposed along the eastern side of the Laramie plains contains a large percentage of gypsum, one stratum near the bottom of the formation being of considerable thickness. The Laramie bed, known locally as a deposit of gypsite, has an average depth of 9 feet, and the mineral needs only to be calcined to prepare it for the market. The manufacture of plaster of Paris and stucco has been carried on at Red Buttes since 1889.[5]

The occurrence of iron ore has been known for some time at a point 24 miles north of Rawlins station. Two mines were opened here in 1871 and worked until 1877. Since that time only a few tons have been mined in this region and these have been used for the manufacture of mineral paints.[6] Hematite ore has been discovered since in Crook, Uinta, Johnson, Fremont, Bighorn, Albany, and Sheridan counties. Besides these hematites, beds of clay ironstone have been found in the Cretaceous rocks and magnetites in the Laramie mountains.[7] Iron mountain, in Laramie county, 52 miles north of Cheyenne, is a mass of red hematite 7 miles long,[7] and Bradleys peak in Carbon county has been called a mountain of iron since it contains not less than 1,500,000,000 tons of iron ore.[7]

About a quarter of a century prior to the great oil excitement in Pennsylvania, Bonneville announced the discovery of oil in Wyoming. Little attention seems to have been paid to his announcement because the territorial geologist, as late as 1890, stated that the first discovery had been made only twenty-five years before. Certainly from 1869 to 1880, little or no attention was paid to oil in the state. In Crook county a company collected oil from the springs and sold it to miners until the advent of the railway, which could bring eastern lubricating oil cheaper than it could be brought in by team from points in Wyoming.

The oil industry of the state was placed on a profitable basis in 1894, when a company at Casper completed its wells in the Salt Creek basin. Because of the necessary haul by wagon and the high freight rates, progress in the development of this industry has been necessarily slow. There are now 19 known fields located in Bighorn, Converse, Crook, Fremont, Natrona, Uinta, and Weston counties.[8] The oil is stored in sandstone, magnesium, limestone, and conglomerate. It occurs in all possible grades, containing in some cases as high as 40 per cent of illuminating oil, and ranges in color from honey-yellow to jet-black.[9]

The semiprecious stones are found in abundance, quartz crystals, agates, jaspers, moss agates, garnets, and beryls being the most important ones. The moss agates found here are the best in the world.[10] No mines were in operation in 1902, though three operators reported the finding of precious stones in surface workings.

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[1] King's Handbook of the United States, pages 906 and 907.

[2] The State of Wyoming, page 13.

[3] United States Geological Survey, "Mineral Resources of the United States," 1887, page 808.

[4] The State of Wyoming, page 16.

[5] The Laramie Cement Plaster, by E. E. Slosson and R. B. Moody, page 3 ff.

[6] Tenth Census of the United States, Vol. XV, page 485.

[7] The State of Wyoming, page 27 ff.

[8] Proceedings of the Wyoming Industrial Convention, 1901, page 39 ff.

[9] The Mineral Industry, 1896, Vol. V, pages 442 to 444.

[10] The State of Wyoming, page 19.

GENERAL TABLES

DETAILED SUMMARY, BY MINERALS AND GROUPS OF MINERALS

TABLE 1.—DETAILED SUMMARY, BY

	MINERALS, BY GROUPS.	Number of mines, quarries, and wells.	NUMBER OF OPERATORS BY CHARACTER OF OWNERSHIP.					SALARIED OFFICIALS, CLERKS, ETC.					
			Total.	Individual.	Firm.	Incorporated company.	Other forms.	Total.		General officers.		Superintendents, managers, foremen, surveyors, etc.	
								Number.	Salaries.	Number.	Salaries.	Number.	Salaries.
1	**All minerals**	151,516	[1]46,858	8,568	3,787	5,384	194	38,128	$39,020,552	4,591	$8,218,541	15,538	$16,666,416
2	**Metallic**	4,280	4,081	1,143	1,314	1,579	45	8,138	9,948,335	774	1,645,670	3,399	4,635,451
3	Copper ore	144	144	19	23	100	2	1,208	1,768,456	116	311,479	400	655,475
4	Gold and silver	2,992	2,992	958	923	1,079	32	3,480	5,076,773	437	810,555	1,725	2,724,092
5	Iron ore	525	332	83	33	214	2	2,405	2,113,230	129	298,076	846	797,807
6	Lead and zinc ore	559	557	66	323	159	9	910	826,327	76	195,910	363	365,089
7	Manganese ore	19	19	8	5	6		18	9,395			11	7,354
8	Quicksilver	41	37	9	7	21		117	154,154	16	29,650	54	85,634
9	**Fuels**	140,463	[1]36,017	3,141	1,206	2,659	86	22,383	22,216,322	2,700	4,795,216	7,666	8,257,890
10	Coal, anthracite	334	119	9	34	76		3,014	2,907,293	134	363,584	848	1,035,290
11	Coal, bituminous	5,652	4,409	2,044	827	1,517	21	14,413	14,511,924	1,741	3,220,054	4,213	4,790,038
12	Natural gas	15,806	1,967	980	276	651	60	1,923	1,810,337	386	560,575	791	723,085
13	Petroleum	118,671	[1]29,522	108	69	415	5	3,033	2,986,768	439	651,003	1,814	1,709,477
14	**Structural materials**	6,044	5,746	3,638	1,166	879	63	6,342	5,699,130	888	1,455,282	3,777	3,151,906
15	Cement	101	93	4	6	83		913	1,087,514	148	347,132	406	476,661
16	Clay	205	203	115	36	52		185	150,505	50	60,295	94	67,492
17	Limestones and dolomites	3,246	3,137	2,282	480	344	31	2,231	1,843,747	336	509,139	1,359	1,011,874
18	Marble	83	75	15	14	45	1	352	341,021	51	99,260	197	180,788
19	Sandstones and quartzites	1,304	1,211	759	324	119	9	847	713,579	101	151,521	531	408,486
20	Siliceous crystalline rocks	906	853	430	219	176	22	1,377	1,227,885	136	220,180	923	799,195
21	Slate	199	174	27	87	60		437	334,879	66	64,755	267	207,915
22	**Abrasive materials**	82	75	39	17	19		75	48,008	16	13,101	43	25,506
23	Buhrstones and millstones	29	29	23	6			7	4,682	1	471	6	4,211
24	Corundum and emery	5	5	1		4		9	5,960	4	2,950	2	1,199
25	Crystalline quartz	6	5	3		2		8	6,030	2	2,000	4	2,830
26	Garnet	7	7	1	3	3		12	9,178	2	2,150	6	4,028
27	Grindstones and pulpstones	9	9	1	3	5		25	13,042	2	480	18	10,132
28	Infusorial earth, tripoli, and pumice.	11	10	3	4	3		8	4,016	1	1,000	5	2,056
29	Oilstones, whetstones, and scythestones.	15	10	7	1	2		6	5,100	4	4,050	2	1,050
30	**Chemical materials**	228	174	34	24	116		750	750,953	115	184,804	421	418,695
31	Borax	6	6			6		14	18,128	1	1,800	7	10,508
32	Fluorspar	22	18	2	2	14		42	27,311	12	11,545	17	12,437
33	Gypsum	62	45	13	6	26		249	300,420	32	73,936	113	153,095
34	Phosphate rock	115	87	18	13	56		391	355,204	64	88,473	253	213,983
35	Sulphur and pyrite	23	18	1	3	14		54	49,890	6	9,050	31	28,582
36	**Pigments**	84	77	24	25	28		91	68,752	25	31,308	38	25,205
37	Barytes	49	42	16	20	6		28	15,159	8	5,308	7	5,570
38	Mineral pigments, crude	35	35	8	5	22		63	53,593	17	26,000	31	19,635
39	**Miscellaneous**	335	688	549	35	104		349	289,052	73	93,160	194	151,773
40	Asbestos	4	4		1	3		7	2,628	2	900	4	1,665
41	Asphaltum and bituminous rock	24	24	3	2	19		52	48,233	23	27,700	17	15,013
42	Bauxite	38	7	2		5		42	33,230	5	10,000	32	19,630
43	Feldspar	27	26	15	3	8		27	20,085	4	4,275	20	14,800
44	Flint	19	17	10	4	3		18	14,330	3	3,875	10	9,105
45	Fuller's earth	4	4	1		3		14	10,000	2	3,500	9	5,000
46	Graphite	28	19	3	1	15		27	18,924	4	2,600	14	10,112
47	Lithium ore	3	3	2	1			1	600			1	600
48	Marl	11	11	9		2		2	2,100			1	1,800
49	Mica	49	38	18	11	9		21	13,444	6	4,300	12	7,314
50	Monazite	23	22	20	1	1		3	2,100			3	2,100
51	Precious stones	46	460	449	1	10		22	28,687	3	2,500	13	21,217
52	Silica sand	28	20	5	5	10		35	27,228	9	10,240	18	13,108
53	Talc and soapstone	20	20	4	3	13		75	63,713	12	23,270	38	28,039
54	Tungsten	4	4	4									
55	Uranium and vanadium	3	3	3				2	3,500			1	2,000
56	All other minerals[2]	6	6	1	2	3		1	240			1	240

[1] Includes 28,925 operators for which no character of ownership was reported.

[2] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

MINERALS AND GROUPS OF MINERALS: 1902.

SALARIED OFFICIALS, CLERKS, ETC.—continued				WAGE EARNERS												
Foremen below ground.		Clerks.		Aggregate.		Above ground										
						Total.		Engineers, firemen, and other mechanics.		Miners and quarrymen, and stonecutters.		Boys under 16 years.		All other wage earners.		
Number.	Salaries.	Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	
6,863	$6,208,307	11,139	$7,127,288	581,728	$260,252,960	225,365	$125,186,530	60,859	$44,478,246	65,120	$33,971,290	6,219	$1,339,478	87,288	$45,297,516	1
2,599	2,100,340	1,665	1,257,871	110,404	81,046,224	38,597	26,706,191	12,443	11,165,863	6,594	3,047,964	598	121,548	18,962	12,370,816	2
237	139,611	555	341,891	26,007	21,151,405	7,584	5,718,599	2,858	2,792,418	53	17,829	68	20,041	4,605	2,888,171	3
860	1,090,483	168	151,163	36,142	36,077,192	11,204	11,293,608	4,513	5,212,222	1,324	1,013,337	21	6,009	5,346	5,062,040	4
782	627,178	618	390,109	38,861	21,551,792	15,769	7,441,835	3,756	2,309,527	4,813	1,781,983	469	77,265	6,731	3,275,060	5
366	209,808	104	75,329	7,881	4,829,271	3,443	1,948,189	1,149	727,212	280	146,573	23	5,644	1,991	1,068,931	6
5	1,990	2	481	194	74,823	125	41,479	26	10,986	33	12,245	13	1,394	53	16,854	7
20	20,220	27	18,650	1,329	881,340	472	324,980	139	113,458	81	40,217	1	1,145	248	169,160	8
1,402	3,743,614	7,616	5,420,612	672,559	236,377,041	86,530	50,015,635	38,465	27,238,965	....	....	4,660	1,014,385	43,405	21,740,284	9
908	812,891	1,034	695,568	69,691	38,716,113	27,964	12,133,983	6,513	3,921,505	....	....	3,822	780,153	17,629	7,432,325	10
3,404	2,920,723	5,095	3,581,109	250,658	181,482,298	36,446	21,701,012	13,632	9,517,916	....	....	846	233,008	21,968	11,950,088	11
....	....	746	526,677	4,678	2,936,279	4,678	2,936,279	1,547	1,165,448	....	....	2	625	3,129	1,770,206	12
....	....	780	626,288	17,552	13,242,361	17,552	13,242,361	16,773	12,654,696	....	....	....	....	779	587,665	13
35	23,771	1,642	1,068,171	85,295	44,654,537	85,384	45,230,027	8,615	5,375,401	53,920	29,642,683	870	188,518	21,979	10,023,425	14
20	15,010	339	248,711	13,041	6,328,852	12,524	6,084,053	2,092	1,324,121	2,766	1,210,291	109	22,530	7,557	3,527,111	15
15	8,761	26	13,957	2,433	958,892	2,039	779,181	106	50,580	1,358	522,896	30	5,548	545	200,157	16
....	....	586	823,234	31,547	14,750,638	31,547	14,750,638	2,233	1,354,053	22,036	10,250,034	258	56,804	7,020	3,089,747	17
....	....	104	60,978	4,070	2,212,640	4,070	2,212,640	517	295,521	2,513	1,418,332	22	3,756	1,018	495,028	18
....	....	215	150,572	10,448	6,153,060	10,448	6,153,060	1,248	779,149	7,117	4,420,075	76	17,142	2,007	936,694	19
....	....	318	208,510	18,836	11,072,996	18,836	11,072,996	1,916	1,300,178	14,474	8,665,190	206	46,434	2,240	1,061,194	20
....	....	104	62,209	5,920	3,177,459	5,920	3,177,459	503	271,796	3,686	2,155,865	169	36,304	1,562	713,494	21
1	600	15	8,801	610	295,914	585	280,416	75	43,772	387	176,798	3	912	120	58,934	22
....	....	....	....	86	39,562	86	39,562	4	2,264	80	36,734	....	....	2	564	23
1	600	2	1,211	47	32,871	25	18,271	6	5,525	11	5,546	....	....	8	7,200	24
....	....	2	1,200	29	13,592	29	13,592	1	600	26	12,392	....	....	2	600	25
....	....	4	3,000	118	59,632	118	59,632	10	4,911	61	29,505	....	....	47	25,213	26
....	....	5	2,430	210	99,598	210	99,598	48	27,110	118	54,270	2	537	42	17,681	27
....	....	2	960	35	13,692	32	11,784	2	930	20	7,254	....	....	10	3,600	28
....	....	....	....	85	37,977	85	37,977	4	2,429	71	31,097	1	375	9	4,076	29
34	20,942	180	125,512	8,845	3,313,098	7,743	2,766,247	782	427,192	4,664	1,482,601	54	8,857	2,243	847,297	30
3	3,480	3	2,250	153	114,965	76	52,811	17	14,257	21	13,300	....	....	38	25,254	31
11	2,849	2	480	269	110,002	110	56,235	25	12,626	56	21,180	2	234	57	22,195	32
12	8,948	92	64,441	1,472	759,258	1,085	551,593	101	63,744	246	121,546	3	500	735	365,803	33
1	375	73	32,473	5,971	1,930,003	5,901	1,908,293	513	278,908	4,313	1,312,379	36	6,106	1,039	306,900	34
7	5,390	10	6,968	970	398,870	541	199,315	126	57,957	28	14,196	13	2,017	374	125,145	35
12	5,251	16	6,988	692	236,372	488	199,407	37	20,669	336	134,676	2	300	113	43,762	36
9	3,001	4	1,290	395	130,295	284	114,551	4	1,650	270	110,086	2	300	8	2,515	37
8	2,250	12	5,708	256	106,087	204	84,856	33	19,019	66	24,590	....	....	105	41,247	38
19	14,789	63	29,330	2,433	1,035,784	2,178	890,607	442	186,104	1,228	486,548	32	4,957	476	212,998	39
....	....	1	63	23	8,250	22	7,875	5	2,079	16	5,328	....	....	1	468	40
1	1,240	11	4,280	156	79,570	140	66,709	17	10,784	101	47,860	....	....	22	8,065	41
....	....	5	3,600	150	59,763	150	59,763	17	10,060	77	24,209	3	450	53	24,994	42
....	....	8	1,020	252	107,444	252	107,444	18	8,954	183	77,541	3	532	48	20,417	43
....	....	5	1,350	119	47,454	119	47,454	11	5,187	65	27,648	....	....	43	14,619	44
....	....	3	1,500	114	33,775	114	33,775	12	6,335	54	17,140	24	3,725	24	6,575	45
5	1,435	4	1,777	164	76,729	101	45,288	27	16,038	33	12,089	1	150	40	17,011	46
....	....	....	....	6	3,744	6	3,744	....	....	6	3,744	....	....	....	....	47
....	....	1	300	13	4,769	13	4,769	2	750	10	3,919	1	100	....	....	48
1	450	2	1,390	98	41,043	81	37,523	12	6,673	58	25,312	....	....	11	5,538	49
....	....	....	....	88	25,318	88	25,318	....	....	86	24,728	....	....	2	590	50
2	2,760	4	2,180	108	58,017	72	56,058	4	3,867	50	39,088	....	....	18	13,103	51
....	....	8	3,880	335	149,114	335	149,114	32	18,140	149	66,074	....	....	154	64,900	52
9	4,404	16	8,000	771	279,083	673	238,046	282	95,047	331	106,281	....	....	60	36,718	53
....	....	....	....	2	1,290	1	540	....	....	1	540	....	....	....	....	54
1	1,500	....	....	19	17,040	5	3,576	2	1,200	3	2,376	....	....	....	....	55
....	....	....	....	15	10,411	6	3,611	1	1,000	5	2,611	....	....	....	....	56

TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	WAGE EARNERS—continued.									
		Below ground.									
		Total.		Miners.		Miners' helpers.		Boys under 16 years.		All other wage-earners.	
		Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
1	**All minerals**	360,223	$244,873,430	257,301	$184,674,193	18,736	$11,496,910	5,638	$1,548,889	78,548	$47,153,438
2	Metallic	71,807	57,340,033	48,530	41,249,966	7,730	5,476,714	101	29,593	15,446	10,583,760
3	Copper ore	18,423	15,442,896	12,768	11,550,164	1,257	777,210	35	13,800	4,363	3,101,722
4	Gold and silver	24,938	24,843,884	18,413	18,737,954	3,293	3,004,334	6	2,517	3,226	3,099,079
5	Iron ore	23,082	14,087,357	13,743	8,868,687	2,293	1,252,772	49	11,709	6,997	3,954,189
6	Lead and zinc ore	4,438	2,381,091	3,010	1,679,325	658	317,050	7	947	763	383,769
7	Manganese ore	69	33,445	63	31,310	3	884			3	1,251
8	Quicksilver	857	551,360	533	382,526	226	124,464	4	620	94	43,750
9	Fuels	286,029	186,363,406	207,040	142,575,514	10,558	5,797,374	5,534	1,518,127	62,897	36,472,391
10	Coal, anthracite	41,727	26,582,130	17,767	14,364,005	6,921	3,643,893	742	182,362	16,297	8,391,870
11	Coal, bituminous	244,302	159,781,276	189,273	128,211,509	3,637	2,153,481	4,792	1,335,765	46,600	28,080,521
12	Natural gas										
13	Petroleum										
14	Structural materials	911	424,510	556	260,333	237	107,711	2	969	116	55,497
15	Cement	517	244,799	265	130,638	220	99,100	2	969	30	14,092
16	Clay	394	179,711	291	129,695	17	8,611			86	41,405
17	Limestones and dolomites										
18	Marble										
19	Sandstones and quartzites										
20	Siliceous crystalline rocks										
21	Slate										
22	Abrasive materials	25	16,498	15	10,648	10	5,850				
23	Buhrstones and millstones										
24	Corundum and emery	22	14,600	12	8,750	10	5,850				
25	Crystalline quartz										
26	Garnet										
27	Grindstones and pulpstones										
28	Infusorial earth, tripoli, and pumice.	3	1,898	3	1,898						
29	Oilstones, whetstones, and scythestones.										
30	Chemical materials	1,092	546,841	875	432,284	144	79,579	1	200	72	34,778
31	Borax	77	62,054	45	37,246	27	20,550			5	4,258
32	Fluorspar	129	53,767	120	50,504	9	3,263				
33	Gypsum	387	207,665	368	198,060					19	9,605
34	Phosphate rock	70	23,800	69	23,600			1	200		
35	Sulphur and pyrite	429	199,555	273	122,874	108	55,766			48	20,915
36	Pigments	104	36,965	75	25,350	20	8,016			9	3,599
37	Barytes	52	15,734	51	15,446	1	288				
38	Mineral pigments, crude	52	21,231	24	9,904	19	7,728			9	3,599
39	Miscellaneous	255	145,177	210	120,098	37	21,666			8	3,413
40	Asbestos	1	375	1	375						
41	Asphaltum and bituminous rock	16	12,861	15	12,070	1	791				
42	Bauxite										
43	Feldspar										
44	Flint										
45	Fuller's earth										
46	Graphite	63	31,441	54	27,672	6	2,350			3	1,419
47	Lithium ore										
48	Marl										
49	Mica	17	6,520	12	4,600	3	1,280			2	640
50	Monazite										
51	Precious stones	36	31,959	29	25,295	5	5,445			2	1,219
52	Silica sand										
53	Talc and soapstone	98	41,037	80	32,402	17	8,500			1	135
54	Tungsten	1	720	1	720						
55	Uranium and vanadium	14	13,464	14	13,464						
56	All other minerals[1]	9	6,800	4	3,500	5	3,300				

[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

AND GROUPS OF MINERALS: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.																			
Engineers.																	Firemen.		
Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.	$0.50 to $0.74.	$0.75 to $0.99.	
1	6	28	273	569	1,264	1,815	3,884	11,500	3,540	697	1,101	186	452	89	762	173	6	50	1
....	....	4	57	132	228	541	698	219	224	98	130	91	380	18	726	147	1	7	2
....	....	....	2	29	10	27	74	43	35	62	21	8	25	10	167	39	....	....	3
....	....	4	26	6	6	2	5	....	31	19	354	74	337	37	548	79	....	1	4
....	....	....	21	91	168	279	378	84	23	7	28	9	17	1	10	29	1	5	5
....	....	....	....	2	44	73	176	85	117	5	24	....	1	....	1	....	....	....	6
....	....	....	8	4	....	....	3	....	....	....	....	....	....	....	....	....	....	....	7
....	....	....	....	....	....	....	2	7	18	5	6	....	....	....	....	....	....	....	8
1	1	9	119	169	592	1,146	2,167	10,911	2,936	662	520	72	60	33	27	23	1	10	9
....	....	8	49	68	273	188	900	247	369	75	13	3	....	....	....	....	....	....	10
....	....	3	8	66	165	218	977	754	930	243	913	50	31	6	11	5	1	10	11
....	....	1	5	4	51	50	80	38	57	14	22	3	1	26	9	2	....	....	12
1	1	2	57	51	63	104	601	9,872	1,580	72	182	36	26	1	7	16	....	....	13
....	5	10	83	231	370	306	949	431	359	101	125	29	9	8	5	2	4	16	14
....	....	....	9	39	17	26	98	58	42	45	26	5	....	3	1	....	....	2	15
....	....	....	6	2	24	2	11	2	4	....	1	1	....	....	....	....	....	1	16
....	....	....	17	3	162	113	288	119	101	45	25	4	2	....	1	2	1	1	17
....	1	....	8	25	12	7	30	6	15	1	6	....	....	1	1	....	....	4	18
....	3	3	12	12	40	31	236	46	68	22	14	7	3	....	2	....	....	1	19
....	1	5	11	17	84	89	225	96	93	20	57	3	1	4	....	....	3	7	20
....	....	2	20	81	48	48	61	7	16	1	1	1	....	....	....	....	....	....	21
....	....	....	....	1	9	1	22	3	2	....	1	....	1	....	....	....	....	....	22
....	....	....	....	....	2	....	....	....	1	....	....	....	....	....	....	....	....	....	23
....	....	....	....	....	....	....	....	2	1	....	....	....	1	....	....	....	....	....	24
....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	25
....	....	....	....	1	2	1	....	....	....	....	....	....	....	....	....	....	....	....	26
....	....	....	....	....	5	....	20	....	....	....	1	....	....	....	....	....	....	....	27
....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	28
....	....	....	....	....	1	....	1	1	....	....	....	....	....	....	....	....	....	....	29
....	....	....	6	13	76	11	75	32	37	1	15	4	2	....	4	1	....	14	30
....	....	....	....	....	....	1	2	....	....	....	1	1	....	....	....	....	....	....	31
....	....	....	....	....	11	....	....	....	2	....	....	....	....	....	....	....	....	....	32
....	....	....	....	1	3	1	21	7	13	....	1	....	....	....	2	....	....	....	33
....	....	....	5	5	12	3	47	24	20	1	11	....	2	....	2	1	....	14	34
....	....	....	1	7	7	6	5	1	2	....	....	....	....	....	....	....	....	....	35
....	....	....	3	1	6	1	6	....	1	....	1	....	....	....	....	....	....	2	36
....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	2	37
....	....	....	3	1	6	1	4	....	1	....	1	....	....	....	....	....	....	....	38
....	....	....	5	20	23	4	25	1	7	2	3	....	....	....	....	....	....	1	39
....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	40
....	....	....	....	2	....	....	2	....	2	....	....	....	....	....	....	....	....	....	41
....	....	....	1	5	1	....	1	....	1	....	....	....	....	....	....	....	....	....	42
....	....	....	....	1	5	2	2	....	1	....	....	....	....	....	....	....	....	....	43
....	....	....	....	....	2	....	2	....	1	....	....	....	....	....	....	....	....	....	44
....	....	....	....	....	1	....	2	....	....	....	1	....	....	....	....	....	....	....	45
....	....	....	....	....	1	....	5	....	....	2	1	....	....	....	....	....	....	....	46
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	47
....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	48
....	....	....	2	1	1	....	....	....	....	....	1	....	....	....	....	....	....	1	49
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	50
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	51
....	....	....	....	1	1	1	15	....	2	....	....	....	....	....	....	....	....	....	52
....	....	....	2	9	4	1	4	1	....	....	....	....	....	....	....	....	....	....	53
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	54
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	55
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TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	AVERAGE NUMBER OF WAGE EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.													
		Firemen—Continued.													
		$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
1	All minerals	281	676	1,646	2,422	1,945	457	762	111	244	20	267	6	38	9
2	Metallic	64	197	198	405	370	73	201	35	168	8	264	5	36	5
3	Copper ore	1	9	10	78	119	4	99	8	20	1	134	2	2	
4	Gold and silver	10		5	1	15	9	72	27	144	5	128	3	34	5
5	Iron ore	49	135	76	315	183	37	9		3	2	2			
6	Lead and zinc ore		53	104	7	41	8	10		1					
7	Manganese ore	4				3									
8	Quicksilver			3	4	9	15	11							
9	Fuels	41	281	1,111	1,566	1,353	323	306	63	62	8	3	1	1	4
10	Coal, anthracite	9	123	621	815	219	21	27	1						
11	Coal, bituminous	32	144	459	721	1,108	283	255	54	38	5	2			
12	Natural gas		14	30	30	21	19	4				1		1	1
13	Petroleum			1		5		20	8	24	3		1		3
14	Structural materials	78	144	292	419	199	57	48	12	14	3			1	
15	Cement	31	27	67	86	87	24	5	1	8					
16	Clay	2	3	10	2	1									
17	Limestones and dolomites	13	68	130	83	35	10	12	4	1					
18	Marble	20	4	13	19	11	5		1	3					
19	Sandstones and quartzites	2	13	18	178	20	4	8	1					1	
20	Siliceous crystalline rocks	6	18	25	33	32	9	23	4	2	2				
21	Slate	4	11	29	18	13	5	5	1		1				
22	Abrasive materials	1			14										
23	Buhrstones and millstones														
24	Corundum and emery														
25	Crystalline quartz														
26	Garnet	1													
27	Grindstones and pulpstones				14										
28	Infusorial earth, tripoli, and pumice.														
29	Oilstones, whetstones, and scythestones.														
30	Chemical materials	84	49	32	17	20	4	6	1						
31	Borax					2			1						
32	Fluorspar	1	1			2									
33	Gypsum	1		5	13	7	1	2							
34	Phosphate rock	76	37	27	3	7	1	4							
35	Sulphur and pyrite	6	11		1	2	2								
36	Pigments	1	1	1		1					1				
37	Barytes														
38	Mineral pigments, crude	1	1	1		1									
39	Miscellaneous	12	4	12	1	2		1							
40	Asbestos	2													
41	Asphaltum and bituminous rock		2		1	1									
42	Bauxite	1		1				1							
43	Feldspar					1									
44	Flint			2											
45	Fuller's earth	3		2											
46	Graphite			1											
47	Lithium ore														
48	Marl	1													
49	Mica														
50	Monazite														
51	Precious stones														
52	Silica sand			3											
53	Talc and soapstone	5	2	3											
54	Tungsten														
55	Uranium and vanadium														
56	All other minerals[1]										1				

[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

AND GROUPS OF MINERALS: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.																
Machinists, blacksmiths, carpenters, and other mechanics.																
$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.	
8	174	400	798	2,333	2,899	5,155	3,916	3,153	1,185	2,151	597	1,021	137	1,144	799	1
	15	51	144	304	494	972	507	635	205	728	175	821	87	1,020	492	2
		3	10	32	90	233	137	260	58	173	49	227	24	273	260	3
	12	12	14	7	11	68	20	135	74	471	109	564	60	737	228	4
	3	33	108	206	341	502	290	186	63	52	12	27	2	10	4	5
		1	11	54	51	159	49	42	7	17	3	2	1			6
		2				2										7
			1	5	1	8	11	12	3	15	2	1				8
5	8	76	254	1,364	1,780	3,224	2,882	1,907	650	1,104	330	151	43	97	298	9
	1	20	67	371	428	823	675	156	47	20	2	4		1		10
4	5	42	175	393	601	1,400	1,876	1,128	419	479	65	76	8	62	6	11
1	2	2	8	51	118	429	193	121	37	35	5	14	1	18	37	12
		12	4	549	633	572	138	502	147	570	258	57	34	16	255	13
2	19	132	341	596	595	876	515	559	322	296	92	44	6	21	3	14
	1	70	120	251	214	300	119	190	49	58	32	5	2	5	1	15
		7	5	12		8	1	1								16
	2	25	77	159	110	207	147	96	72	24	3	9		3	1	17
	1	2	88	50	22	31	78	23	2	7	4	10	1	2		18
1	6	10	20	34	142	99	36	51	24	44	13	3	3	2		19
1	9	18	25	73	85	199	107	185	172	158	38	15		9		20
			6	17	22	32	27	13	3	5	2	2			1	21
	1			3	7	7	1							1		22
				1		1										23
							1							1		24
																25
	1			1	1	2										26
				1	6	3										27
																28
						1										29
1	20	31	52	43	12	49	11	35		10		3	1	3	6	30
				3								2		1		31
				2				1		2						32
			1	1	3	8	4			1				1	1	33
1	20	8	28	25	4	35	7	29		6		1	1	1	5	34
		23	23	12	5	6		5		1						35
		1		1		1		3		6						36
																37
		1		1		1		3		6						38
	111	106	7	22	11	26		14	8	7		2		2		39
		1						1								40
					1	4								2		41
								3	2							42
				1	3	2										43
				1		1										44
				3												45
			3	4		2		5	4							46
																47
																48
	1		1	1		1						2				49
																50
						1				3						51
				1	2	4		1								52
	110	105	3	9	5	9		4	2	4						53
																54
						2										55
																56

TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	AVERAGE NUMBER OF WAGE EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.													
		Miners and quarrymen and stonecutters.													
		Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.
1	All minerals	29	222	2,832	14,978	18,903	36,669	57,492	65,267	39,895	[illegible]	19,446	22,197	8,854	16,094
2	Metallic		23	483	3,311	1,643	3,595	2,700	8,655	4,759	[illegible]	3,002	7,904	779	9,930
3	Copper ore			24	1	61	36	157	3,216	1,970	1,679	758	54	7	5,582
4	Gold and silver		10	113	156	119	117	176	257	278	2,869	2,258	7,290	746	4,310
5	Iron ore		13	296	3,001	1,057	2,478	1,585	3,936	2,642	2,087	483	394	21	55
6	Lead and zinc ore				47	300	909	548	1,217	124	93	2	8	1	1
7	Manganese ore				77	1	1				7				32
8	Quicksilver				32	105	54	41	20	77	219	[illegible]	48	2	
9	Fuels	29	86	342	2,513	6,042	19,354	25,986	49,825	32,080	28,103	14,596	11,932	7,373	5,523
10	Coal, anthracite					26	271	1,101	8,293	3,776	2,195	1,542	1,692	1,373	1,313
11	Coal, bituminous	29	86	342	2,513	6,016	19,083	24,885	41,532	28,304	25,908	13,053	10,240	6,000	4,210
12	Natural gas														
13	Petroleum														
14	Structural materials		103	933	5,330	10,286	12,609	8,848	6,641	2,188	1,947	1,738	2,241	701	632
15	Cement		2	54	350	1,166	895	427	109	27	32	8	2		
16	Clay		1	275	206	730	252	84	76	81	29	7	6		
17	Limestones and dolomites		35	215	3,106	5,450	6,232	1,011	1,651	578	317	66	144	105	106
18	Marble		1	12	468	585	438	116	150	55	199	141	112	78	47
19	Sandstones and quartzites		9	20	125	587	1,509	1,177	1,097	928	293	211	573	90	304
20	Siliceous crystalline rocks		52	350	958	1,583	2,683	2,648	1,738	835	814	1,163	1,318	428	175
21	Slate		3	7	117	185	588	565	1,100	600	263	142	86		
22	Abrasive materials			13	38	66	160	50	35	4	7	1	8		
23	Buhrstones and millstones				4	14	60	16	5			1			
24	Corundum and emery						8	8					7		
25	Crystalline quartz						21	4	1						
26	Garnet			12		1	10	18	20						
27	Grindstones and pulpstones				9	43	32	21	1	3	6				
28	Infusorial earth, tripoli, and pumice.				14	4	1		3				1		
29	Oilstones, whetstones, and scythe stones.			1	11	4	48		5	1	1				
30	Chemical materials		6	1,010	3,058	461	583	169	115	22	60	2	46		1
31	Borax						8		11		20		27		
32	Fluorspar				35	100	32	5	4						
33	Gypsum					25	329	158	50	21	22		9		
34	Phosphate rock		6	1,010	2,990	226	126	1	7	1	2	2	4		1
35	Sulphur and pyrite				33	110	88	5	43		16		6		
36	Pigments		1	36	149	53	98	69	4		1				
37	Barytes		1	15	135	30	74	66							
38	Mineral pigments, crude			21	14	23	24	3	4		1				
39	Miscellaneous		3	65	576	362	210	43	62	11	51	18	36	1	8
40	Asbestos				13	1	3								
41	Asphaltum and bituminous rock				36	11	11	2	3		25	11			
42	Bauxite			5	64	8									
43	Feldspar				1	135	74	1			2				
44	Flint				23	20	15	2	1				4		
45	Fuller's earth			35	29	1	5	3							
46	Graphite			2	24	6	37	3	5	9	1				
47	Lithium ore				1			4						1	
48	Marl			4	3		3								
49	Mica			8	41	2	3		3		12		2		
50	Monazite			13	73										
51	Precious stones				6		5	8	15	5	8	4	33		8
52	Silica sand			2		73	41	13	20						
53	Talc and soapstone		3	25	249	104	33	3	4						
54	Tungsten							1			1				
55	Uranium and vanadium												17		
56	All other minerals[1]			2				3			2		5		

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[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 2.

AND GROUPS OF MINERALS: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.																		
Miners and quarrymen and stonecutters—Cont'd.			Miners' helpers.															
$3.75 to $3.99.	$4.00 to $4.25.	$4.25 and over.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	
2,078	1,750	1,063	26	252	1,390	2,004	2,599	3,700	3,021	1,907	1,429	488	1,180	392	341	5	4	1
202	950	61	19	63	576	671	860	1,287	1,265	385	909	125	1,050	248	340	5	4	2
1	40	16	3		119	86	77	497	336	53	30	30	18		38			3
199	910	40	16	49	262	25	29	119	136	184	810	102	1,016	248	302	5	4	4
2		5		13	151	194	465	618	645	105	38	10	16					5
					3	302	288	21	124	21								6
					1	2												7
				1	40	62	1	32	24	22	41	7						8
1,821	564	865	7	186	778	1,294	1,529	2,379	1,747	1,522	458	363	130	144	1			9
517	166	502		2	141	947	921	2,086	1,295	1,233	117							10
1,304	398	363	7	184	637	347	608	293	452	289	341	363	130	144	1			11
																		12
																		13
43	234	135				2	228	3	4									14
							220											15
						2	8	3	1									16
	39	1																17
2	4	95																18
23	81	30																19
18	110	9																20
																		21
							5	5										22
																		23
							5	5										24
																		25
																		26
																		27
																		28
																		29
2	2	2			31	33	6	12			62							30
											27							31
					1	8												32
																		33
2	2	2																34
					30	25	6	12			35							35
				1	3		11	8										36
				1														37
					3		11	8										38
10				2	2	4	27	1	5				6					39
																		40
								1										41
																		42
																		43
																		44
																		45
					2	4												46
																		47
																		48
				2									2					49
																		50
10													5					51
																		52
							17											53
																		54
									5									55
																		56

TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.															
		Timbermen and track layers.															
		$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
1	All minerals	1	46	206	381	1,119	2,102	3,778	3,640	954	312	399	59	456	26	57	5
2	Metallic		5	35	97	148	765	991	301	406	30	215	51	428	26	57	3
3	Copper ore			6		14	95	359	55	32	3	28	21	207	17	26	
4	Gold and silver							1		57	23	177	28	207	9	31	3
5	Iron ore		5	29	86	121	667	607	245	317	4	2	2	14			
6	Lead and zinc ore				11	7	3	13	1			1					
7	Manganese ore																
8	Quicksilver					6		11				7					
9	Fuels	1	29	71	270	954	1,315	2,786	3,339	548	282	184	8	28			2
10	Coal, anthracite		2	50	61	304	624	326	579	23	5	2	1				
11	Coal, bituminous	1	27	21	209	650	691	2,460	2,760	525	277	182	7	28			2
12	Natural gas																
13	Petroleum																
14	Structural materials		2		14	1	5										
15	Cement				14	1	5										
16	Clay		2														
17	Limestones and dolomites																
18	Marble																
19	Sandstones and quartzites																
20	Siliceous crystalline rocks																
21	Slate																
22	Abrasive materials																
23	Buhrstones and millstones																
24	Corundum and emery																
25	Crystalline quartz																
26	Garnet																
27	Grindstones and pulpstones																
28	Infusorial earth, tripoli, and pumice.																
29	Oilstones, whetstones, and scythe-stones.																
30	Chemical materials		10	100		1	17										
31	Borax																
32	Fluorspar																
33	Gypsum																
34	Phosphate rock		10	100			1										
35	Sulphur and pyrite					1	16										
36	Pigments					12											
37	Barytes																
38	Mineral pigments, crude					12											
39	Miscellaneous					3		1									
40	Asbestos																
41	Asphaltum and bituminous rock							1									
42	Bauxite																
43	Feldspar																
44	Flint																
45	Fuller's earth																
46	Graphite					3											
47	Lithium ore																
48	Marl																
49	Mica																
50	Monazite																
51	Precious stones																
52	Silica sand																
53	Talc and soapstone																
54	Tungsten																
55	Uranium and vanadium																
56	All other minerals[1]																

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[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

AND GROUPS OF MINERALS: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.																		
Boys under 16 years.									All other wage-earners.									
Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	
447	3,448	4,062	3,212	419	130	61	56	22	61	960	3,615	12,960	21,351	32,442	25,073	27,543	12,328	1
163	287	116	44	45	14		17	10		70	510	1,666	2,120	4,459	6,533	5,607	1,444	2
	12	8	20	34	7		12	10		14	17	58	137	1,661	2,430	1,928	158	3
4	6	4	1	5	2		5			22	48	104	51	107	288	693	292	4
141	250	99	17	8	3					15	434	1,314	1,195	1,913	3,582	2,291	459	5
5	12	5	5	1	2					2	2	108	691	750	220	571	207	6
11	2											32	3	1				7
2	5		1							17	9	30	43	27	13	121	28	8
155	2,834	3,636	2,988	358	112	60	39	12	3	666	2,323	8,143	12,064	19,699	16,056	20,120	10,397	9
69	2,006	1,881	580	26	2				1	453	1,919	5,397	7,177	7,949	6,038	1,793	746	10
86	828	1,751	2,407	332	110	60	39	12	2	212	395	2,721	4,659	10,566	9,291	17,842	9,309	11
		1	1							1	7	20	222	1,098	666	560	306	12
											2	5	6	86	41	225	36	13
115	285	276	179	12	4	1			3	125	450	2,339	6,795	7,510	2,273	1,382	445	14
37	15	38	19	1	1					3	97	620	2,482	2,455	974	279	200	15
9	13	5	3						2	30	47	270	129	36	48	21	9	16
16	95	84	60	3						65	87	905	2,215	2,508	627	176	31	17
6	14				2					1	44	60	261	343	92	68	58	18
4	26	25	18	2		1				1	5	125	561	766	267	173	70	19
36	56	49	59	5	1				1	20	153	230	448	739	190	269	45	20
7	66	75	20	1						5	17	129	699	163	75	96	32	21
		2		1							6	14	16	35	21	20		22
													2					23
																		24
												2						25
											6		1		20	20		26
		2										2	18	27				27
												10						28
				1										8	1			29
12	37	5	1						55	100	282	705	211	505	177	88	40	30
														11	3	1	[illegible]	31
		2										2	45	8		7		32
	3										1	32	55	416	161	64	16	33
7	27	2	1						45	55	282	476	82	20	18	5		34
5	7	1							10	45	49	195	29	55		11	11	35
	2										16	40	13	31	6	3		36
	2											8						37
											16	32	13	31	6	3		38
2	3	27								1	28	53	182	203	7	23	2	39
														1				40
											2	8	6	4	1			41
1	2											3	10	40				42
		3										1	23	21	2	1		43
										1		31	9	2				44
		24									15	5	4					45
	1										6	1	8	24			1	46
1																		47
																		48
											4	3	1					49
											1	1						50
														8		3	1	51
													57	79	2	16		52
													11	24	2	3		53
																		54
																		55
																		56

TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	AVERAGE NUMBER OF WAGE EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.								AVERAGE NUMBER OF WAGE EARNERS EMPLOYED DURING EACH MONTH.				
		All other wage earners—Continued.								Men 16 years and over.				
		$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.	January.	February.	March.	April.	May.
1	All minerals	6,172	2,297	4,299	625	1,493	86	459	268	599,362	587,181	595,413	604,359	556,461
2	Metallic	2,029	620	3,277	183	1,594	34	397	196	102,212	101,514	104,087	107,995	112,382
3	Copper ore	250	152	327	45	759		97	72	24,885	24,658	25,602	26,088	27,073
4	Gold and silver	1,553	401	2,803	105	825	32	290	119	34,678	34,925	34,810	35,955	37,164
5	Iron ore	251	65	52	28	10	2	10	5	33,854	33,105	34,714	36,820	39,291
6	Lead and zinc ore	47	12	92	6					7,725	7,266	7,465	7,695	7,945
7	Manganese ore									165	141	172	178	167
8	Quicksilver	28		2						1,335	1,329	1,321	1,335	1,422
9	Fuels	4,000	1,592	838	102	70	18	32	59	416,024	412,953	405,798	397,890	357,130
10	Coal, anthracite	245	149	79	3					110,018	110,760	109,165	109,150	53,169
11	Coal, bituminous	3,347	1,407	666	99	51	6	24	28	284,823	281,380	277,676	267,399	262,358
12	Natural gas	144	21	10		12	10	6	25	3,819	3,675	3,661	3,866	4,111
13	Petroleum	264	15	83		7	2	2	6	17,464	17,258	17,546	17,455	17,492
14	Structural materials	418	70	106	25	29	4	30	13	61,467	61,746	72,024	86,313	93,730
15	Cement	164	30	31	12	11	2	1	3	10,330	10,272	10,771	12,290	13,180
16	Clay	34		3						2,119	2,160	2,231	2,405	2,575
17	Limestones and dolomites	54	6	24	2	7	1	15		22,381	22,586	27,391	32,808	34,907
18	Marble	57	11	2				8	10	3,546	3,503	3,856	4,063	4,294
19	Sandstones and quartzites	31	1	3		4				5,693	5,766	7,719	10,338	12,673
20	Siliceous crystalline rocks	26	5	33	9	5	1	6		12,289	12,665	14,755	18,674	20,138
21	Slate	52	14	10		2				5,109	5,144	5,392	5,734	5,963
22	Abrasive materials	6		2						427	437	475	605	669
23	Buhrstones and millstones									74	76	87	92	98
24	Corundum and emery	6		2						36	37	35	38	47
25	Crystalline quartz									17	17	17	27	28
26	Garnet									62	62	68	137	143
27	Grindstones and pulpstones									149	153	165	193	212
28	Infusorial earth, tripoli, and pumice									29	29	29	31	38
29	Oilstones, whetstones, and scythe-stones.									60	63	74	87	103
30	Chemical materials	14		11						7,610	7,869	8,111	8,612	8,880
31	Borax	14		2						170	170	174	174	174
32	Fluorspar									161	147	147	183	265
33	Gypsum			9						779	1,271	1,391	1,449	1,521
34	Phosphate rock									5,562	5,486	5,521	5,841	6,011
35	Sulphur and pyrite									937	915	905	966	992
36	Pigments	1								487	668	646	666	667
37	Barytes									241	412	414	418	413
38	Mineral pigments, crude	1								246	256	232	237	254
39	Miscellaneous	[illegible]	3	[illegible]	10					2,109	2,024	2,272	2,581	2,180
40	Asbestos									15	10	14	14	7
41	Asphaltum and bituminous rock									130	139	146	140	152
42	Bauxite									135	147	147	147	164
43	Feldspar									226	225	229	248	249
44	Flint									99	90	100	149	131
45	Fuller's earth									88	85	60	66	66
46	Graphite									137	138	152	149	167
47	Lithium ore													
48	Marl									10	19	16	10	10
49	Mica	4		1						73	76	78	101	98
50	Monazite									27	20	108	118	136
51	Precious stones	1	1	4						92	90	87	112	109
52	Silica sand									270	284	323	343	355
53	Talc and soapstone		2		10					760	715	769	783	815
54	Tungsten									3	5	3	3	
55	Uranium and vanadium									9	11	17	19	22
56	All other minerals[1]									7	7	8	9	13

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[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

AND GROUPS OF MINERALS, 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH—continued.

Men 16 years and over—Continued.							Boys under 16 years.												
June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	
518,197	509,596	521,089	520,932	566,761	633,639	627,629	15,440	15,454	15,614	15,807	10,466	7,267	7,274	7,445	7,501	9,295	15,286	15,592	1
112,567	114,043	114,130	113,243	113,683	111,256	108,760	590	581	642	689	728	713	771	773	766	744	708	681	2
26,466	25,858	25,908	25,698	26,273	25,750	25,689	111	110	113	113	110	106	112	92	92	95	91	93	3
37,309	37,104	37,140	36,780	36,756	36,126	34,680	27	27	27	31	28	24	26	26	24	25	28	27	4
39,311	40,694	41,425	41,250	40,958	39,850	38,706	405	397	454	497	539	531	573	599	598	570	542	511	5
7,996	8,008	8,181	8,067	8,125	8,034	8,172	27	27	28	28	31	32	45	31	32	32	27	30	6
185	180	184	167	196	206	228	13	13	13	13	13	13	15	13	13	15	13	13	7
1,300	1,289	1,291	1,319	1,325	1,351	1,335	7	7	7	7	7	7	14	12	7	7	7	7	8
293,039	280,790	293,986	304,591	344,440	431,671	432,023	14,078	14,097	14,092	14,137	8,636	5,504	5,397	5,578	5,665	7,441	13,633	14,067	9
16,301	6,493	7,610	8,136	54,773	145,516	140,268	8,362	8,468	8,419	8,517	2,986	52	59	96	100	1,696	7,804	8,209	10
257,803	255,181	263,666	271,101	266,311	262,891	267,284	5,714	5,627	5,671	5,618	5,648	5,450	5,336	5,480	5,563	5,743	5,827	5,856	11
1,571	1,632	5,163	5,668	5,493	5,330	6,555	2	2	2	2	2	2	2	2	2	2	2	2	12
17,364	17,484	17,547	17,508	17,863	17,934	18,001													13
96,886	98,228	99,778	98,638	95,475	86,381	75,017	695	698	802	885	945	946	996	986	971	927	868	776	14
13,280	13,479	14,506	14,549	14,349	14,185	13,969	96	92	112	123	123	116	115	116	117	110	110	102	15
2,621	2,604	2,568	2,480	2,472	2,363	2,386	28	28	28	28	33	34	34	33	32	27	27	28	16
35,690	35,170	35,677	36,232	34,067	30,357	26,069	200	204	247	269	277	269	294	288	289	280	257	222	17
4,165	4,166	4,258	4,409	4,266	4,100	3,971	28	25	25	26	22	19	20	20	21	20	19	19	18
13,801	13,257	13,012	12,699	11,897	10,428	7,712	31	28	46	67	105	105	111	111	96	83	78	48	19
21,362	22,433	22,692	22,092	21,788	19,167	15,613	153	163	178	208	212	227	245	241	239	231	201	174	20
5,967	6,126	6,176	6,167	6,047	5,791	5,406	159	158	166	164	173	176	176	177	177	176	166	163	21
675	674	700	696	696	639	702	1	3	3	3	3	3	3	3	3	3	3	4	22
87	89	83	88	91	95	79													23
56	58	61	59	55	42	49													24
28	28	14	10	34	34	31													25
135	136	135	145	138	140	116													26
231	228	219	213	218	218	207	2	2	2	2	2	2	2	2	2	2	2	2	27
38	36	36	37	39	39	39													28
98	104	102	87	91	71	68		1	1	1	1	1	1	1	1	1	1	2	29
9,384	9,395	9,261	9,377	9,241	8,843	8,571	42	41	45	62	61	64	69	66	57	57	49	51	30
96	96	96	168	171	174	170													31
280	336	340	551	475	336	296							1	1	1	1	1	1	32
1,608	1,560	1,480	1,606	1,685	1,656	1,583	5	5	3	3	3	4	2	2	3	2	2	2	33
6,368	6,355	6,322	6,108	6,081	5,777	5,718	30	30	30	42	41	42	43	42	39	39	38	31	34
1,032	1,011	1,004	950	928	900	807	8	8	10	16	17	18	18	16	11	12	10	12	35
691	695	701	591	474	412	396	4	4				1	1	4	4				36
426	427	437	303	294	153	144	4	4				4	4	4	4				37
265	268	264	288	180	259	252													38
2,456	2,511	2,487	2,681	2,672	2,397	2,280	30	30	27	32	33	33	31	33	32	33	32	32	39
7	8	17	32	65	83	29													40
129	144	157	164	190	202	180													41
147	143	153	115	160	146	130	2	2	3	3	4	4	4	4	3	1	2	2	42
256	276	269	272	252	254	252	2	2	2	3	3	3	3	3	3	1	1	5	43
137	138	134	151	127	129	91													44
55	58	60	100	158	148	138	21	21	21	21	21	21	24	26	24	24	21	24	45
171	163	163	171	185	176	175	1	1	1	1	1	1	1	1	1	1	1	1	46
21	23	23	5																47
10	11	15	15	15	17	13	1	1	1	1	1	1	1	1	1	1	1	1	48
106	108	112	108	100	104	105													49
119	127	130	119	127	20	20													50
141	140	120	118	94	29	94													51
341	352	366	380	257	728	531													52
761	791	826	841	766	708	711													53
3	9																		54
27	27	27	27	22	12	11													55
23	25	23	27	13	12	13													56

TABLE 1.—DETAILED SUMMARY, BY MINERALS

	MINERALS, BY GROUPS.	CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.	
		Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		Quantity (short tons).	Value.
1	All minerals	$20,677,938	21,183	$71,771,713	$34,530,713	$37,241,000	$123,814,967		$796,826,417
2	Metallic	1,371,921	2,557	17,168,321	9,591,964	7,576,357	39,639,703		215,453,587
3	Copper ore	188,768	195	1,397,465	130,215	1,267,250	11,083,175		51,178,035
4	Gold and silver	626,020	980	5,357,529	1,423,399	3,934,130	16,690,768		82,482,052
5	Iron ore	425,292	1,079	8,257,714	6,503,908	1,753,806	9,005,608	[2]35,567,410	65,465,321
6	Lead and zinc ore	108,607	223	2,092,001	1,525,368	566,633	2,511,657	[3]623,662	14,600,177
7	Manganese ore			3,845	1,996	1,849	17,228	[2]16,477	177,911
8	Quicksilver	23,164	80	59,767	7,078	52,689	322,267	(4)	1,550,020
9	Fuels	19,066,167	17,988	47,805,681	23,264,926	24,540,755	61,928,460		469,297,671
10	Coal, anthracite	406,421	1,731	9,307,239	4,359,051	4,948,188	12,740,780	[2]36,940,710	76,173,586
11	Coal, bituminous	1,244,114	5,010	16,774,459	7,442,089	9,332,370	24,798,922	260,216,844	290,858,483
12	Natural gas	4,459,001	3,298	5,912,257	2,533,895	3,378,362	6,607,255		30,867,863
13	Petroleum	12,956,631	7,949	15,811,726	8,929,891	6,881,835	17,781,512	[5]89,275,302	71,397,739
14	Structural materials	60,749	208	5,750,482	1,260,673	4,489,809	20,072,399		96,370,559
15	Cement	10,627	34	1,665,520	52,905	1,612,615	9,088,226	[6]24,655,300	24,268,338
16	Clay	13,241	36	126,873	59,387	67,486	272,823	1,455,357	2,061,072
17	Limestones and dolomites	36,381	137	1,440,081	422,693	1,017,388	5,403,912		30,441,801
18	Marble			382,877	65,385	317,492	825,822		5,044,182
19	Sandstones and quartzites	500	1	878,780	196,144	682,636	1,298,190		10,601,171
20	Siliceous crystalline rocks			810,206	194,892	615,314	2,493,065		18,257,944
21	Slate			446,145	269,267	176,878	690,361	(7)	5,696,051
22	Abrasive materials			42,410	8,421	33,989	80,309		1,177,711
23	Buhrstones and millstones			1,480	636	844	1,809	[8]6,667	59,808
24	Corundum and emery			2,779	1,091	1,688	26,114	4,251	104,605
25	Crystalline quartz			1,950	1,825	125	950	15,104	43,085
26	Garnet			4,952	1,341	3,611	10,128	3,926	132,820
27	Grindstones and pulpstones			24,433	2,003	22,430	31,349	55,657	667,431
28	Infusorial earth, tripoli, and pumice.			2,263	1,050	1,213	2,297	6,415	55,994
29	Oilstones, whetstones, and scythe-stones.			4,553	475	4,078	7,662	3,876	113,968
30	Chemical materials	161,095	331	741,570	296,410	445,160	1,603,348		10,618,669
31	Borax			47,606	19,200	28,406	213,898	[9]19,142	2,383,614
32	Fluorspar	300	3	23,602	7,900	15,702	31,374	48,818	275,682
33	Gypsum	106	7	200,769	49,912	150,857	341,760	681,633	2,089,341
34	Phosphate rock	157,102	306	430,475	212,350	218,125	799,114	[2]1,548,720	4,922,943
35	Sulphur and pyrite	3,587	15	39,118	7,048	32,070	217,202	[2]207,874	947,089
36	Pigments	1,000	10	60,448	40,626	19,822	65,845		564,039
37	Barytes	1,000	10	35,555	27,300	8,255	7,772	61,668	203,154
38	Mineral pigments, crude			24,893	13,326	11,567	58,073	35,479	360,885
39	Miscellaneous	16,406	89	202,801	67,693	135,108	424,894		3,341,181
40	Asbestos			1,758		1,758	8,253	2,565	16,200
41	Asphaltum and bituminous rock	10,060	60	19,753	2,856	16,897	21,928	66,238	236,728
42	Bauxite	500	10	14,939	2,090	12,849	10,019	[2]29,222	128,206
43	Feldspar			19,407	10,584	8,823	50,278	[2]45,287	250,424
44	Flint			14,291	5,813	8,478	18,642	[11]36,365	144,209
45	Fuller's earth	4,021	8	2,357		2,357	28,990	11,492	98,144
46	Graphite	900	2	6,039	520	5,519	31,840	[12]27,458	227,508
47	Lithium ore			200		200	1,255	1,245	25,750
48	Marl			1,407		1,407	2,755	22,439	12,741
49	Mica			12,914	3,142	9,772	11,961	(13)	118,849
50	Monazite			2,083	1,739	344	256	[14]802,000	64,160
51	Precious stones			7,481	437	7,044	17,781		328,450
52	Silica sand	100	2	18,776	8,373	10,403	58,386	145,963	121,292
53	Talc and soapstone			80,136	31,364	48,772	125,992	97,954	1,138,167
54	Tungsten			120		120	230	184	5,975
55	Uranium and vanadium			190		190	1,010	3,810	48,125
56	All other minerals[15]	825	7	950	775	175	3,432	3,326	49,276

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[1] Includes electric and other horsepower "supplied by other establishments," but does not include horsepower of electric motors owned.

[2] Long tons.

[3] Includes 132,330 short tons of lead ore and 491,332 short tons of zinc ore.

[4] Quicksilver, flasks, 34,291 (76½ pounds each); cinnabar, 11,727 short tons.

[5] Barrels of 42 gallons.

[6] Barrels.

[7] Roofing slate reported, 1,435,168 squares; quantity for other uses not given.

[8] Number of stones.

AND GROUPS OF MINERALS: 1902—Continued.

POWER.														
Total horsepower.	Owned.										Supplied—			
	Engines.				Water wheels.		Electric motors.		Other power.		To other establishments.	By other establishments.		
	Steam.		Gas or gasoline.									Electric.	Other.	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Horsepower.	Horsepower.	Horsepower.	
2,867,562	64,179	2,432,963	13,506	259,635	990	60,897	2,893	130,494	1,162	81,516	2,852	23,556	5,905	1
557,466	4,976	455,202	293	5,913	818	15,614	883	46,742	494	31,077	641	16,812	3,415	2
198,507	792	189,426	35	1,184	8	326	50	2,312	31	5,235	87	2,336		3
195,805	1,925	122,354	198	4,060	788	45,926	750	32,003	176	8,003	323	14,469	2,985	4
119,558	1,182	102,878	11	86	11	1,010	35	937	240	15,444	140		140	5
41,901	1,060	38,616	32	431	8	320	45	1,475	39	2,335	91	7	192	6
354	11	354												7
1,808	56	1,574	17	152	3	22	3	15	5	60				8
1,969,569	53,729	1,666,227	13,064	248,892	11	1,384	1,411	71,802	568	48,217	2,163	2,517	2,332	9
434,220	5,629	415,827	6	185			78	5,755	234	18,208	350			10
521,165	6,516	489,628	152	1,119	11	1,384	1,325	65,972	285	26,675	1,181	2,167	192	11
104,107	787	94,595	300	7,083			6	50	12	2,162	20	225	42	12
910,077	41,797	666,177	12,606	240,505			2	25	37	1,172	612	125	2,098	13
295,448	4,825	272,317	109	4,286	78	8,616	571	20,941	89	4,682	48	4,217	136	14
114,022	465	102,811	15	2,890	21	1,854	474	17,420	9	2,095	20	3,442		15
4,478	98	3,942	2	18	1	25			22	403				16
64,530	1,703	61,547	39	1,061	15	502	36	769	25	1,221	3	102	97	17
14,256	192	10,718			15	3,413	32	2,220	2	125				18
25,652	789	24,631	7	72	6	885	6	140	8	53		7	4	19
46,968	950	44,189	25	275	15	1,596	23	142	19	510	25	471	35	20
25,454	520	24,649			5	125	1	30	4	186		196		21
2,495	71	2,300	7	88			1	5	3	95			12	22
85									2	85				23
110	2	30	3	80										24
20	1	20												25
430	7	420							1	10				26
1,247	41	1,235											12	27
410	7	410					1	5						28
193	13	185	4	8										29
28,860	404	27,009	24	302	13	1,094	18	671	6	405			50	30
338	5	205	11	123	1	10	1	1						31
669	17	530	10	139			1	25						32
7,319	68	6,385	2	20	11	914	5	68						33
14,229	282	13,974			1	170	9	500	2	85				34
6,305	32	5,915	1	20			2	80	4	320			50	35
1,950	30	1,310	2	40	9	550			1	50				36
110	3	110												37
1,840	27	1,250	2	40	6	500			1	50				38
11,307	141	7,398	7	174	81	3,645	9	330	1	20		10	60	39
165	2	165												40
720	11	660	1	60			1	25						41
624	19	575	2	49			1	64						42
1,204	15	854			7	350								43
740	3	155			20	585								44
360	7	330	2	30										45
769	18	739			1	10						20		46
														47
80	1	80												48
180	8	155	1	25			1	10						49
30	2	30												50
140	4	140												51
2,000	[illegible]	1,980							1	20				52
7,945	32	5,235	1	10	6	2,700	8	225						53
280	4	220											60	54
														55
15	1	15												56

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[9] Includes 2,600 short tons of crude.
[10] Includes 21,850 short tons of crude.
[11] Includes 16,070 short tons of ground.
[12] Includes 5,162 short tons of refined.
[13] Cut or sheet mica, 373,266 pounds; scrap or waste, 1,400 short tons.
[14] Pounds.
[15] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

DETAILED SUMMARY, BY STATES AND TERRITORIES

TABLE 2.—DETAILED SUMMARY, BY

	STATE OR TERRITORY.	Number of mines, quarries, and wells.	NUMBER OF OPERATORS BY CHARACTER OF OWNERSHIP.					SALARIED OFFICIALS, CLERKS, ETC.					
			Total.	Individual.	Firm.	Incorporated company.	Other forms.	Total.		General officers.		Superintendents, managers, foremen, surveyors, etc.	
								Number.	Salaries.	Number.	Salaries.	Number.	Salaries.
1	United States	151,516	[1]46,855	8,568	3,787	5,381	194	38,128	$39,020,552	4,591	$8,218,541	15,538	$16,666,416
2	Alabama	290	172	48	13	111	....	947	979,117	97	206,176	334	381,563
3	Arizona	113	158	66	25	67	....	145	710,183	53	115,981	182	325,642
4	Arkansas	120	131	79	19	33	....	210	191,528	22	39,575	80	68,918
5	California[2]	4,037	1,552	589	430	514	19	1,152	1,887,800	257	353,119	747	1,102,505
6	Colorado	1,147	1,011	270	249	484	8	1,898	2,053,333	217	471,538	771	1,205,543
7	Connecticut	90	78	40	17	19	2	151	132,196	22	30,629	100	83,343
8	Delaware	12	12	3	2	7	....	29	28,047	9	12,000	14	12,571
9	Florida	71	46	11	7	28	....	218	228,868	36	60,500	132	135,560
10	Georgia	149	127	40	26	61	....	304	209,281	45	54,275	168	109,073
11	Idaho	292	290	99	112	77	2	354	576,190	42	107,179	159	260,117
12	Illinois	1,116	1,013	550	200	251	12	1,869	1,910,940	272	409,911	526	550,587
13	Indian Territory	79	39	4	8	27	....	240	253,171	34	47,939	88	103,531
14	Indiana	16,825	3,909	593	229	480	45	1,662	1,491,558	301	395,343	701	603,948
15	Iowa	625	589	344	133	101	11	610	540,125	87	112,805	192	150,338
16	Kansas	1,259	398	193	94	101	9	565	527,242	81	131,443	168	168,044
17	Kentucky	1,142	665	432	51	175	6	854	666,900	194	211,563	308	244,844
18	Louisiana	8	3	....	....	3	....	8	7,551	....	....	3	4,400
19	Maine	135	141	72	37	32	....	208	193,814	20	26,423	143	129,378
20	Maryland	232	209	134	24	50	1	308	465,665	99	258,717	130	109,209
21	Massachusetts	251	234	135	45	37	17	300	309,978	19	37,708	255	218,276
22	Michigan	203	146	25	7	114	....	1,585	1,840,132	193	353,649	513	681,502
23	Minnesota	176	255	180	29	41	5	675	577,896	45	72,978	232	224,386
24	Missouri	1,045	973	393	334	231	15	1,458	1,253,821	164	306,791	537	487,625
25	Montana	281	271	100	75	94	2	571	912,177	51	124,765	217	406,859
26	Nebraska	36	35	23	9	3	....	12	8,091	....	....	10	7,091
27	Nevada	114	121	48	24	47	2	146	222,098	32	58,224	69	111,391
28	New Hampshire	56	62	36	13	13	....	92	68,971	8	6,025	66	54,291
29	New Jersey	162	151	77	25	49	....	420	357,000	40	70,370	180	164,778
30	New Mexico	161	207	119	20	62	6	175	209,569	6	19,500	90	123,065
31	New York	9,768	2,921	479	196	119	4	791	788,382	102	211,270	437	399,850
32	North Carolina	126	137	80	26	30	1	120	84,224	9	7,920	75	58,073
33	North Dakota	48	48	29	9	9	1	32	43,980	8	7,400	18	18,960
34	Ohio	44,934	11,338	785	226	321	9	2,580	2,551,083	341	645,492	1,077	1,115,776
35	Oklahoma	21	17	12	1	4	....	18	12,223	4	2,962	11	7,995
36	Oregon	294	293	128	107	58		153	189,103	27	25,102	86	116,296
37	Pennsylvania	48,672	12,266	1,364	492	596	8	9,368	9,592,910	769	1,790,531	3,454	3,775,985
38	Rhode Island	22	22	11	8	3	....	56	56,150	7	15,620	25	22,048
39	South Carolina	38	42	14	6	22	....	118	126,992	17	23,280	109	87,969
40	South Dakota	77	77	33	12	29	3	167	242,161	13	20,925	80	117,183
41	Tennessee	241	203	67	33	100	3	773	661,379	130	186,618	338	275,196
42	Texas	1,067	308	69	53	183	3	1,210	661,802	258	169,543	643	346,285
43	Utah	178	170	40	34	96	....	413	587,005	81	132,031	142	231,930
44	Vermont	192	160	60	73	27	....	433	376,077	30	61,150	260	232,551
45	Virginia	192	140	40	37	63	....	700	546,204	66	134,378	327	228,221
46	Washington	90	84	14	20	50	....	258	328,290	35	53,296	109	160,756
47	West Virginia	14,874	5,392	608	74	274	1	2,614	2,113,170	276	453,576	1,053	1,045,821
48	Wisconsin	411	392	210	114	67	1	275	232,758	31	48,592	134	101,777
49	Wyoming	74	50	20	9	21	....	153	188,616	19	33,322	57	78,296

[1] Includes 28,925 operators for which character of organization was not reported, distributed as follows: Indiana, 2,562; Kansas, 1; Kentucky, 1; New York, 2,123; Ohio, 9,997; Pennsylvania, 9,806, and West Virginia, 4,435.

[2] Includes 2 operators in Alaska and 1 in Hawaii.

STATES AND TERRITORIES: 1902.

SALARIED OFFICIALS, CLERKS, ETC.—continued.				WAGE-EARNERS.												
						Above ground.										
Foremen, below ground.		Clerks.		Aggregate.		Total.		Engineers, firemen, and other mechanics.		Miners and quarrymen, and stonecutters.		Boys under 16 years.		All other wage-earners.		
Number.	Salaries.	Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	
6,863	$6,208,307	11,130	$7,927,288	581,728	$369,959,960	221,505	$125,096,530	60,859	$44,478,246	67,129	$33,971,290	6,219	$1,339,478	87,298	$45,297,516	1
160	186,949	356	254,129	19,132	10,345,148	6,001	2,477,581	1,146	636,710	2,107	814,297	268	55,377	2,480	971,197	2
94	150,625	116	117,935	5,323	5,059,065	1,720	1,647,840	672	830,619	58	54,073	47	25,720	943	737,428	3
35	30,702	73	52,335	2,944	1,945,479	812	409,741	221	151,783	256	108,204	20	3,845	315	145,909	4
198	224,623	250	207,323	12,964	11,050,666	6,319	5,326,422	2,177	2,194,091	1,923	1,408,748	16	5,304	2,203	1,718,279	5
370	451,887	540	684,365	20,519	18,874,895	5,728	5,422,100	2,250	2,528,046	626	457,631	41	14,253	2,811	2,422,170	6
1	772	29	17,351	1,197	908,772	1,437	786,446	175	111,141	992	553,973	7	1,605	263	119,727	7
		6	3,476	504	222,622	437	196,969	44	25,856	224	100,756	8	2,500	161	67,857	8
2	1,025	48	31,783	3,116	1,062,030	3,118	1,073,530	348	194,625	2,183	694,745	39	6,249	548	177,911	9
40	19,142	51	25,791	2,820	1,085,047	2,401	927,338	324	162,461	1,487	567,191	91	11,992	499	165,404	10
111	161,995	42	47,399	3,563	3,903,504	938	1,003,812	380	457,710	164	141,693	2	350	392	404,059	11
410	388,570	661	466,922	40,523	26,986,397	7,500	4,503,947	2,034	1,476,622	2,377	1,296,098	76	23,767	3,013	1,707,460	12
49	44,849	89	56,953	4,814	3,183,322	787	457,881	342	225,113	17	9,734	26	7,880	402	215,154	13
144	116,127	516	315,120	16,473	10,729,767	6,907	3,989,236	2,903	2,019,381	2,118	1,030,431	62	16,101	1,824	923,323	14
172	127,790	159	100,193	10,437	6,791,161	1,942	1,103,314	465	310,238	566	297,389	15	4,492	896	491,195	15
134	97,315	190	130,140	8,726	6,680,593	2,359	1,329,558	575	416,025	672	346,053	12	3,524	1,100	563,956	16
146	99,175	206	110,178	10,664	5,193,792	2,781	1,246,332	659	395,520	999	387,146	28	4,743	1,095	458,923	17
		5	3,133	61	34,444	61	34,444	11	9,527					50	24,917	18
		45	38,013	3,684	2,284,789	3,683	2,284,414	344	233,549	2,627	1,710,596	34	10,271	678	329,998	19
51	38,376	109	59,333	6,835	1,323,939	2,394	1,134,215	354	212,122	1,240	581,726	68	14,449	732	325,918	20
7	1,575	79	49,419	4,242	2,625,405	4,140	2,472,288	451	312,901	2,978	1,834,380	22	5,726	689	319,281	21
487	470,653	452	845,828	31,951	20,103,616	10,578	6,184,324	3,050	2,096,701	936	476,116	12	2,952	6,580	3,608,555	22
200	172,827	198	107,245	9,760	6,391,184	4,172	2,670,752	973	679,426	1,257	856,728	7	1,527	1,935	1,133,071	23
455	299,195	292	109,900	15,351	8,737,267	5,700	3,111,848	1,405	890,039	1,553	808,891	46	10,904	2,696	1,402,014	24
133	220,156	170	100,797	10,539	11,812,150	2,520	2,825,852	1,310	1,609,631	283	270,275			927	945,946	25
		2	1,000	178	95,935	178	95,935	9	5,038	127	68,705	2	615	40	20,677	26
21	32,623	24	19,960	1,132	1,205,066	410	437,291	132	171,769	23	17,423	2	540	253	247,559	27
		18	8,655	1,253	806,194	1,252	806,169	157	100,601	1,051	689,870	8	2,323	36	13,375	28
90	53,100	110	68,752	5,615	2,656,727	4,436	2,075,139	567	346,808	2,204	1,004,604	19	4,076	1,646	719,651	29
13	40,838	36	26,166	2,275	1,646,853	594	432,223	227	202,526	148	83,012	6	1,999	213	144,686	30
51	36,624	198	140,638	9,560	5,099,733	8,387	4,557,510	1,390	921,733	3,921	2,152,957	68	16,812	3,008	1,466,008	31
16	6,816	20	11,415	1,556	517,765	1,138	387,744	130	57,717	720	257,366	19	2,916	269	69,745	32
20	13,180	6	4,440	298	128,534	42	28,630	21	16,540					21	12,090	33
313	229,960	799	559,845	37,173	23,222,680	13,765	8,060,591	6,399	4,439,454	3,547	1,669,904	46	11,739	3,773	1,939,484	34
		3	1,266	128	64,545	128	64,545	12	8,241	71	34,769	1	105	44	21,430	35
22	30,415	18	16,960	1,166	1,033,075	562	473,043	142	158,045	259	191,931	8	2,264	153	120,803	36
1,950	1,697,462	3,109	2,319,092	190,935	114,122,437	68,390	34,532,467	18,859	12,544,444	12,002	5,901,829	4,263	888,416	33,266	15,197,778	37
		24	18,452	667	435,224	667	435,224	87	57,899	458	322,077			122	55,248	38
2	950	20	14,793	2,694	891,737	2,613	863,637	262	137,823	1,799	583,676	30	4,318	522	137,820	39
56	86,683	19	17,570	3,131	3,574,776	1,069	1,066,146	335	417,819	190	154,462	1	150	543	493,715	40
104	77,818	201	124,747	10,890	4,864,241	4,722	1,671,384	665	302,864	2,697	850,708	179	33,171	1,281	484,641	41
24	16,628	285	132,346	3,853	2,261,639	1,823	1,255,452	660	617,496	470	255,689	17	3,593	676	378,674	42
91	124,202	99	98,812	5,712	5,099,122	1,436	1,249,954	442	458,901	170	129,179	10	3,662	814	658,212	43
		134	82,376	5,398	3,114,399	5,393	3,112,563	520	316,803	3,644	2,137,192	64	15,898	1,165	642,670	44
97	64,697	210	118,908	8,993	3,458,450	5,289	1,846,131	961	427,378	2,957	994,236	287	48,031	1,084	376,490	45
72	77,869	42	36,368	4,567	3,735,484	1,208	844,457	340	283,063	252	178,695	31	10,666	585	372,033	46
404	332,677	901	611,176	30,002	17,469,826	10,158	6,080,421	5,340	3,766,693	1,096	546,864	190	48,356	3,532	1,718,508	47
53	38,183	57	41,306	3,583	1,987,565	2,294	1,222,787	312	189,056	1,630	866,648	10	1,984	342	165,119	48
27	30,734	50	46,264	4,486	3,452,059	1,153	886,990	397	348,798	140	102,330	11	4,413	605	431,449	49

	STATE OR TERRITORY.	WAGE-EARNERS—continued.									
		Below ground.									
		Total.		Miners.		Miners' helpers.		Boys under 16 years.		All other wage-earners.	
		Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
1	United States	360,225	$244,873,436	257,501	$184,674,193	18,736	$11,196,910	5,670	$1,638,889	78,318	$47,363,498
2	Alabama	13,131	7,867,567	9,861	6,395,562	510	216,045	392	116,523	2,368	1,142,536
3	Arizona	3,603	3,411,225	2,316	2,392,174	807	583,456	3	1,300	477	434,595
4	Arkansas	2,132	1,535,768	1,325	1,161,172	10	5,490	32	7,614	765	361,492
5	California	6,645	5,724,241	4,710	4,261,193	1,298	981,145	3	1,060	634	480,846
6	Colorado	14,791	13,152,736	11,396	10,399,651	823	838,256	66	59,890	2,506	2,194,849
7	Connecticut	60	22,326	34	12,822					26	9,504
8	Delaware	67	25,663	22	8,810					45	16,853
9	Florida	28	8,840	28	8,840						
10	Georgia	419	187,709	275	113,684	73	22,661	6	1,060	65	50,304
11	Idaho	2,625	2,899,092	2,041	2,364,463	358	282,671	1	842	225	251,116
12	Illinois	33,023	22,182,510	25,214	17,773,212	654	525,223	850	256,019	6,305	3,628,056
13	Indian Territory	4,027	2,725,411	2,785	1,946,375	31	21,329	100	28,588	1,111	729,119
14	Indiana	9,566	6,740,231	7,310	5,278,103	63	32,724	117	35,165	2,076	1,394,239
15	Iowa	8,495	5,687,847	6,595	4,580,555	165	105,454	159	18,725	1,576	1,003,113
16	Kansas	6,367	4,351,005	5,148	3,595,818	30	15,767	39	9,013	1,150	730,407
17	Kentucky	7,875	5,947,460	5,857	5,065,185	151	64,768	199	41,381	1,668	776,126
18	Louisiana										
19	Maine	1	375	1	375						
20	Maryland	4,432	3,189,724	3,619	2,765,325			107	35,935	706	388,464
21	Massachusetts	102	53,117	36	21,032	22	12,900			44	19,185
22	Michigan	21,373	13,919,292	12,710	8,789,531	1,413	829,662	42	16,163	7,208	4,283,936
23	Minnesota	5,588	3,725,402	3,463	2,432,457	393	238,182			1,732	1,054,763
24	Missouri	9,651	5,615,519	7,229	4,360,494	623	312,330	67	16,687	1,732	926,008
25	Montana	8,019	8,986,308	6,615	7,511,382	396	327,136	9	3,088	1,009	1,144,702
26	Nebraska										
27	Nevada	722	768,274	653	710,561	18	16,776			51	40,937
28	New Hampshire	1	325	1	325						
29	New Jersey	1,209	583,588	334	169,316	313	144,009			562	270,263
30	New Mexico	1,691	1,214,640	1,371	1,006,976	73	42,285	17	5,588	230	159,791
31	New York	1,193	542,243	680	323,262	293	133,388	2	972	218	84,621
32	North Carolina	418	130,021	280	91,197	72	21,062			66	17,762
33	North Dakota	253	167,901	190	127,083			1	200	62	40,618
34	Ohio	23,408	15,162,099	18,168	12,151,236	64	36,061	318	91,178	4,858	2,883,554
35	Oklahoma										
36	Oregon	604	562,032	468	445,346	64	60,989	1	340	71	55,357
37	Pennsylvania	122,545	79,589,970	84,017	58,709,222	7,600	4,059,067	2,160	575,797	28,768	16,245,867
38	Rhode Island										
39	South Carolina	81	28,100	28	10,300	20	6,000			33	11,800
40	South Dakota	2,062	2,308,620	991	1,175,655	143	463,308			928	669,657
41	Tennessee	6,168	3,192,857	4,264	2,580,285	606	247,922	147	25,820	1,151	338,730
42	Texas	2,030	1,026,187	1,585	842,519	168	56,788	32	4,882	245	121,998
43	Utah	4,276	3,842,168	3,400	3,104,341	366	261,198	11	4,392	499	472,237
44	Vermont	5	1,899	5	1,899						
45	Virginia	3,704	1,612,316	2,829	1,297,103	103	42,309	101	18,467	671	325,416
46	Washington	3,359	2,891,027	2,537	2,279,892	71	54,600	8	2,492	743	554,039
47	West Virginia	19,864	11,380,465	13,186	8,373,109	628	314,008	680	168,218	5,370	2,525,128
48	Wisconsin	1,289	764,848	911	559,374	8	3,471	1	1,657	369	190,296
49	Wyoming	3,333	2,545,069	2,258	1,878,129	75	46,656	24	9,957	976	610,418

AND TERRITORIES: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.																			
Engineers.																	Firemen.		
Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.	$0.50 to $0.74.	$0.75 to $0.99.	
1	6	23	273	569	1,264	1,813	3,884	11,500	3,546	667	1,101	196	452	89	762	173	6	50	1
			1	23	95	42	46	15	63	6	1	1						2	2
			1				1		1	1	3	3	25	11	86	19			3
			2	10	14	7	23	9	6										4
	1	1	7	2	1	8	39	52	223	12	271	36	62	2	59	14			5
			1		1	1	8	22	33	51	192	42	71	15	240	36			6
			1	4	7	6	35	11	5		1							1	7
				1	9	1	1	1	1				1	5				1	8
			3	1	41	8	47	21	10	1	3		1		1				9
	1		29	33	12	6	30	2	4	1	3							2	10
											6	4	69	4	57	10			11
		1	2	4	14	16	178	171	259	58	61	12	3	2	3	3			12
					1	3	46	38	24	4	1		8						13
			23	22	87	96	334	1,222	153	27	23	2	1	2	2	2			14
				1	8	17	103	31	29	5	6								15
		1			19	37	61	57	38	6	3					1		1	16
1			9	19	37	22	71	25	13	1	4		1	1		1	1		17
									1										18
		1		3	12	9	40	13	3	6	1	1							19
			3	14	23	18	30	8	24	1	2								20
			1	1	15	25	52	15	50	8	12	3	1					1	21
			1	23	11	135	322	71	67	61	13			1					22
			2	1	2	16	98	68	30	4	20	9	14	1	1	27			23
			1	6	45	83	212	103	131	12	30	1	1			1			24
							1		2	1	13	2	28	2	242	28			25
							1	1			1								26
						1	1			1	10		10	2	13	12			27
				1	4	13	19	11	3		1								28
	1		3	5	48	58	32	9	12	5	5	3							29
							1		4	12	28	4	13	1	3	4			30
	1	1	16	12	37	60	99	315	55	5	7			2	1				31
			15	8	5	1	4										1	3	32
							2	2	1		4			1					33
		1	17	34	78	258	674	3,322	94	53	10	2	1		3				34
					1	1	1	1	2		1								35
					1		2	2	11	4	6	2	10	3	9	1			36
		7	88	225	425	698	1,011	3,904	1,396	192	113	11	8	25	2	1			37
				1	1	11	13	1	1										38
			8	5	22	2	7		19		9		1		1	1	2	18	39
											6		57		48				40
		1	9	23	40	17	48	15	6	3	3							1	41
		3	1	10	12	14	17	18	47	15	128	11	23		7	8		10	42
				1			1	1	6	7	35	23	42	6	18	1			43
			6	7	7	27	68	18	26								1		44
	1	5	18	55	43	17	22	12	13	4	1	2		1		1	1	2	45
		1				1	2	13	30	10	21	5	3	4	1				46
			3	10	64	43	122	1,971	601	16	15	2	1		3				47
	1		2	4	19	49	34	5	7	2	4		1					1	48
						1	5	4	25	4	21	3	1		2	2			49

TABLE 2.—DETAILED SUMMARY, BY STATES

	STATE OR TERRITORY.	AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.													
		Firemen—Continued.													
		$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
1	United States	281	676	1,646	2,422	1,945	457	562	111	244	22	267	6	38	9
2	Alabama	14	95	72	91	6									
3	Arizona							13	10	9		31	2	1	
4	Arkansas	3	6	11	24	4	2								
5	California			3	6	15	14	58	10	18	1	6	1	3	
6	Colorado				1	25	28	58	26	55	6	65		17	
7	Connecticut	1	1	8	3	4									
8	Delaware			3		3	3								
9	Florida	46	34	29	3	3	1								
10	Georgia	30	14	3		11		2							
11	Idaho			3		2				3	3	32	3	4	1
12	Illinois	1	5	13	130	298	32	18	1	1					
13	Indian Territory		1	23	33	17	8	3		8					
14	Indiana	2	39	98	51	95	18	4	1			1			
15	Iowa		3	27	30	42	8	3		1					
16	Kansas	1	8	42	4	11	3								1
17	Kentucky	5	20	46	16	17	1	3							
18	Louisiana					1									
19	Maine		1	9	16	9		5							
20	Maryland	4	5	16	5	9	18	1			2				
21	Massachusetts		2	3	2	1	2	1	2						
22	Michigan		4	30	365	199	18	87	1	5					
23	Minnesota			1	49	87	31	6	2	3					
24	Missouri		99	130	15	50	9	14	2	1					
25	Montana		1					5	9	30		122		10	
26	Nebraska														
27	Nevada					1	1			4		2		2	2
28	New Hampshire			1	1	1	1			1					
29	New Jersey		9	47	23	21	9	6	1						
30	New Mexico				1	8	1	11		5		3			
31	New York	3	34	37	35	52	8	1							
32	North Carolina	12	8	2	2										
33	North Dakota								2						
34	Ohio	2	12	37	249	125	22	4	1						
35	Oklahoma			1		1		1							
36	Oregon					3		5	2	2		1			
37	Pennsylvania	44	201	768	1,095	692	159	106	5	2	2	2		1	
38	Rhode Island			2	1										
39	South Carolina	35	3	1	1	1		14							
40	South Dakota				1			3	1	14					
41	Tennessee	17	36	35	12	13		3							
42	Texas		2	10	16	7	3	13	4	17	5				2
43	Utah			2		5	6	26	10	31	1	1			2
44	Vermont	2		7	23	9	2	4	1	1					
45	Virginia	52	13	25	16	4									
46	Washington		1		6	14	27	28	9	3		1			
47	West Virginia	7	17	94	76	50	15	6							1
48	Wisconsin		2	7	26	17	1								
49	Wyoming				1	23	6	55	11		2				

AND TERRITORIES: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.																		
Boys under 16 years.									All other wage-earners.									
Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	
447	3,448	4,062	3,212	419	130	61	56	22	61	960	3,615	12,960	21,351	32,442	25,073	27,545	12,328	1
43	140	264	105	8		22	36	12		9	229	1,360	1,043	845	651	156	157	2
			18	3	7		12	10					8	41	90	312	227	3
3	6	36	7							1	3	43	71	183	61	192	207	4
2	4		7	1	3		2			17	10	13	101	111	116	670	298	5
			69	17	8		3				1	54	21	73	702	543	176	6
	1	6									1	19	91	141	25	8	1	7
			8									18	118	60	9			8
6	7	25	1								48	282	78	25	12	3		9
48	47	2								20	129	271	76	50	1	1	1	10
1		1	1								2	9	10	2	2	6	3	11
2	17	54	778	64	10	1				2	10	83	153	842	1,568	4,011	1,127	12
	1	58	41	17	9						5	4	89	271	101	378	267	13
1	14	27	135	2						6	5	81	343	702	138	368	1,373	14
	3	13	132	24	2					1	2	18	59	426	366	990	114	15
2	1	16	21			2					1	103	79	675	167	706	229	16
11	137	45	20	12	2					31	24	448	670	563	662	96	38	17
														50				18
	3	13	16	1	1						1	42	225	207	77	77	25	19
6	67	36	14	19	9	21			2	4	5	127	221	302	333	131	26	20
1	4	8	9							1	10	42	133	422	60	29	6	21
	3	5	7	39						1	16	108	233	8,180	5,031	2,776	468	22
2	2	1	1	1						1		7	16	174	965	1,435	251	23
9	33	17	41	10	3				1	6	25	173	972	1,090	435	1,006	333	24
			9									1	2			20	14	25
		1	1										1	4	31			26
		1			1									20	13	12	1	27
	1	1	6								2	22	1	6	3	1	1	28
	9	7	3							5	6	53	981	898	107	72		29
		2	15	5	1							3	4	16	99	55	29	30
1	10	35	20	3	1					5	8	124	946	1,631	268	143	43	31
9	10									22	188	116				8		32
	1										1	1	6	13	8	19	21	33
3	24	105	215	6	8	5				12	79	274	603	2,252	814	8,447	313	34
		1											5	32		7		35
		1	7	1								1	2	4		133	9	36
111	2,221	2,727	1,208	123	33	5			2	498	2,084	6,870	11,387	13,290	8,780	7,898	5,102	37
										1	19	2	12	58	7	16	3	38
10	20								44	100	217	153	27	4	3	5	1	39
	1											2	4	9	22	20	1	40
28	205	91	1	1					1	79	276	590	296	656	140	94	33	41
8	12	8	11							55	69	41	80	160	201	58	29	42
1	1		12		4		3			1		12	6	30	51	170	124	43
	13	29	20	2							9	48	216	398	152	97	58	44
127	171	63	27						10	50	103	676	200	187	207	33	38	45
	4	6	15	8	6				1	2		9	21	99	70	183	400	46
12	251	353	207	40	7					30	25	610	1,702	2,076	1,726	867	256	47
	4	4	2		3						1	39	30	110	342	51	1	48
			7	12	12	4						8	9	42	253	275	410	49

TABLE 2.—DETAILED SUMMARY, BY STATES

	STATE OR TERRITORY.	AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY—continued.								AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH.				
		All other wage-earners—Continued.								Men 16 years and over.				
		$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.	January.	February.	March.	April.	May.
1	United States	6,472	2,297	4,299	625	1,493	56	459	268	590,362	587,181	595,413	604,359	556,464
2	Alabama	35	35	7	1					18,101	18,007	18,341	18,629	18,499
3	Arizona	104	125	216	43	146		41	6	4,972	4,963	5,059	6,229	5,550
4	Arkansas	63	10	1				3		3,130	3,073	2,819	2,677	2,664
5	California	815	101	297	38	94	18	20	12	12,179	12,273	12,635	13,257	13,346
6	Colorado	638	684	1,268	241	242	15	138	50	20,406	20,493	19,671	19,647	19,984
7	Connecticut									787	760	937	1,133	1,696
8	Delaware	1								190	208	104	531	655
9	Florida									3,130	2,988	2,995	3,043	3,018
10	Georgia	1								2,531	2,509	2,692	2,674	2,729
11	Idaho	18	41	126	93	132		53	4	3,226	3,275	3,422	3,593	3,690
12	Illinois	168	19	27	1	2				39,433	39,375	39,303	37,586	37,049
13	Indian Territory	92	110	17	15					5,040	4,952	4,589	4,151	4,099
14	Indiana	112	64	6				1	1	14,972	15,047	15,747	15,924	16,699
15	Iowa	316	3	7	3		1			11,248	11,098	10,342	9,040	8,968
16	Kansas	116	9	42	3	3	2		1	9,288	9,020	8,843	8,212	7,998
17	Kentucky	20	3	1	1	1	1	1		10,855	10,191	10,043	9,830	9,765
18	Louisiana									59	59	59	59	59
19	Maine	11	4	8				1		2,619	2,813	3,048	3,797	3,984
20	Maryland	22	1							6,919	6,313	6,558	6,752	6,966
21	Massachusetts	6	1	1			1	1		3,001	3,004	3,250	4,283	4,283
22	Michigan	201	55	39	6	2	1	13	3	30,625	29,680	30,809	30,219	31,932
23	Minnesota	86	47	20	27	5	1	6	2	7,919	7,067	7,516	8,862	10,285
24	Missouri	88	19	88	11			13		15,131	15,057	14,830	14,631	14,914
25	Montana	145	41	533	32	664	2	106	91	9,442	9,942	10,224	10,296	10,711
26	Nebraska			1						55	75	128	207	191
27	Nevada	9	7	184	6	16		15	21	949	930	987	1,115	1,224
28	New Hampshire									177	590	717	1,261	1,519
29	New Jersey	5	2			1				4,858	4,451	4,808	5,871	6,109
30	New Mexico	73	38	49		8		1	2	2,384	2,179	2,187	2,164	2,152
31	New York	39	17	24	17	15	2		1	5,184	6,158	6,858	9,225	10,820
32	North Carolina									1,001	1,066	1,283	1,619	1,817
33	North Dakota	6								169	351	277	178	164
34	Ohio	166	16	7	15	21		15	2	34,157	34,004	35,088	35,713	36,036
35	Oklahoma									67	73	89	136	152
36	Oregon	21	25	1	10	5		3	3	1,008	1,050	1,107	1,243	1,236
37	Pennsylvania	1,571	429	177	15	22	11	8	24	224,167	222,954	224,621	226,463	171,258
38	Rhode Island	1						3		151	178	600	634	769
39	South Carolina									2,657	2,628	2,715	2,856	2,695
40	South Dakota	180	9	794	5	81	1	3	31	2,919	2,941	2,950	3,087	3,102
41	Tennessee	82	1	1						10,250	10,042	10,592	10,726	11,014
42	Texas	133	4	41		1		1		3,560	3,607	3,786	3,806	3,953
43	Utah	569	194	129	21	11				5,814	5,752	5,684	5,482	5,590
44	Vermont	59	17	82	9	2		8	10	4,589	4,694	5,073	5,405	5,631
45	Virginia	2								7,833	7,666	8,218	8,523	8,878
46	Washington	144	103	78	1	15		1		4,670	4,672	4,601	4,602	4,198
47	West Virginia	140	35	9	11	4		1		31,120	31,082	31,558	32,001	31,730
48	Wisconsin	2						3		2,528	2,828	3,065	3,590	4,032
49	Wyoming	421	31	15		2			4	5,105	4,824	4,587	4,158	3,804

AND TERRITORIES: 1902—Continued.

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH—continued.																			
Men 16 years and over—Continued.							Boys under 16 years.												
June.	July.	August.	September.	October.	November.	December	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
518,197	509,598	521,089	520,932	566,591	631,629	627,629	15,410	15,454	15,613	15,807	10,405	7,257	7,274	7,443	7,501	9,205	15,283	15,591	1
18,710	16,773	18,379	18,774	19,225	19,349	19,237	643	619	615	602	628	623	589	664	664	652	640	613	2
5,523	5,347	5,386	5,220	5,275	5,267	5,477	50	50	50	50	50	50	51	48	51	50	50	50	3
2,675	2,652	2,787	2,937	3,056	3,043	3,191	54	56	51	42	49	46	53	58	59	49	56	52	4
13,100	13,040	13,179	13,122	13,342	13,181	12,706	15	15	18	20	20	19	26	24	19	19	17	16	5
20,536	20,286	20,653	20,990	21,313	21,139	20,046	99	99	91	88	95	98	102	95	99	95	104	108	6
1,963	2,028	2,075	2,037	1,814	1,436	1,014	7	8	6	9	10	10	10	8	5	4	4	3	7
666	662	515	568	595	536	426	....	....	9	9	9	9	10	10	10	10	10	10	8
3,071	3,035	3,076	3,135	3,288	3,231	3,244	33	33	33	44	44	44	45	41	41	41	33	33	9
2,706	2,772	2,875	2,822	2,858	2,897	2,721	86	94	90	102	91	96	106	104	103	103	96	93	10
3,765	3,778	3,738	3,714	3,667	3,587	3,315	1	1	1	1	4	4	4	4	4	4	4	4	11
37,132	37,751	38,281	40,541	42,726	42,887	43,100	917	897	918	906	888	887	879	913	951	975	995	986	12
4,487	4,603	4,671	4,920	4,786	5,083	5,185	126	124	124	120	119	119	128	130	127	129	135	131	13
15,891	16,200	16,578	17,385	17,813	17,415	16,857	156	159	173	175	184	185	195	186	195	189	182	160	14
8,916	9,325	9,694	10,626	11,157	11,345	11,357	178	171	170	165	166	164	172	181	187	182	177	180	15
8,035	8,316	8,502	8,844	9,232	8,885	9,033	41	41	44	40	41	40	39	41	43	41	45	45	16
9,486	9,926	10,243	10,721	11,264	11,590	11,587	219	223	231	227	218	214	249	229	230	231	229	224	17
62	69	59	60	60	60	60	....	....	....	....	....	....	....	....	....	....	....	....	18
4,455	4,530	4,612	4,450	3,825	3,175	2,491	26	32	28	32	34	38	38	41	41	38	33	27	19
6,667	6,776	6,861	6,745	6,805	6,675	6,185	161	157	182	179	178	164	176	176	178	189	182	178	20
4,889	5,112	4,983	4,956	4,960	4,419	3,181	20	20	18	23	23	26	27	23	23	22	20	19	21
30,991	31,508	32,711	33,840	34,143	33,074	32,825	58	56	58	60	56	54	62	47	49	50	49	49	22
10,577	10,257	11,200	11,454	11,262	10,848	9,849	3	3	5	7	9	9	10	10	10	9	6	5	23
15,001	15,112	15,252	15,194	15,777	15,906	16,021	103	103	109	104	107	106	119	121	122	123	118	121	24
10,842	11,053	10,491	10,651	10,909	11,067	10,752	20	18	10	9	8	8	9	7	5	5	5	4	25
233	224	220	225	218	186	150	2	2	2	2	2	2	2	2	2	2	2	2	26
1,251	1,234	1,215	1,193	1,182	1,174	1,106	3	3	3	3	1	1	1	1	1	1	3	3	27
1,463	1,580	1,620	1,583	1,704	1,498	1,032	2	2	2	11	11	11	11	11	11	11	11	2	28
6,166	6,446	6,437	6,137	5,904	5,000	5,195	14	14	15	17	19	20	22	22	23	22	21	19	29
2,272	2,280	2,394	2,219	2,345	2,248	2,242	25	21	25	27	28	20	25	22	22	22	21	20	30
11,360	11,294	11,318	11,299	10,944	10,003	8,420	56	56	60	69	78	82	81	81	73	72	72	60	31
1,781	1,808	1,842	1,798	1,695	1,541	1,330	19	18	20	19	18	20	21	19	22	19	16	17	32
174	168	192	243	382	492	541	1	1	1	1	1	1	1	1	1	1	1	1	33
36,510	36,897	37,991	38,208	39,166	38,905	39,135	327	319	340	341	358	358	382	386	375	402	398	379	34
178	138	142	148	168	157	135	....	....	....	2	2	2	2	2	1	1	....	....	35
1,284	1,264	1,278	1,207	1,134	1,127	1,046	10	10	10	8	9	7	7	7	7	11	11	11	36
136,110	127,112	130,514	132,006	150,190	228,070	231,705	10,156	10,195	10,217	10,392	1,866	1,951	1,968	2,028	2,016	3,584	9,671	10,082	37
751	785	799	754	711	665	705	....	....	....	....	....	....	....	....	....	....	....	....	38
2,644	2,042	2,877	2,789	2,667	2,406	2,930	30	31	33	31	31	31	32	33	33	33	21	21	39
3,407	3,180	3,210	3,234	3,293	3,261	3,216	....	....	....	....	2	2	2	2	2	2	....	....	40
11,214	10,813	10,412	10,392	10,278	10,806	10,828	312	313	316	320	328	334	329	330	337	338	327	331	41
3,946	3,954	3,871	3,763	3,844	3,863	3,875	38	38	40	40	39	39	39	39	39	39	39	39	42
5,479	5,647	5,750	5,910	5,807	5,806	5,735	20	22	19	21	19	22	23	21	22	19	21	23	43
4,633	5,681	5,676	4,866	5,623	5,266	4,011	62	62	62	63	64	65	67	64	64	64	62	64	44
8,790	9,245	9,570	8,945	8,845	8,503	8,446	324	315	352	386	415	404	410	437	434	400	385	372	45
4,189	4,478	4,595	4,407	4,676	4,715	4,672	41	42	43	42	36	35	33	35	36	42	42	42	46
25,548	22,866	24,136	28,820	29,276	31,408	32,640	980	974	982	985	999	782	682	673	718	906	921	940	47
4,155	4,036	4,000	3,928	3,800	3,486	2,324	1	1	6	10	16	22	22	23	18	13	10	8	48
3,876	4,037	4,160	4,516	4,733	4,768	4,896	31	31	31	32	35	35	35	35	36	39	37	38	49

TABLE 2.—DETAILED SUMMARY, BY STATES

	STATE OR TERRITORY.	CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	Value of product.
		Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		
1	United States	$20,677,938	21,183	$71,771,713	$34,530,713	$37,241,000	$125,814,967	$796,826,417
2	Alabama	267,279	1,420	858,851	195,045	663,806	2,045,914	15,367,992
3	Arizona	159,912	179	392,195	18,367	373,828	3,060,521	11,197,175
4	Arkansas	860	13	95,481	40,818	54,663	244,379	2,810,341
5	California	520,894	604	1,783,790	685,982	1,097,808	5,673,755	28,870,805
6	Colorado	393,985	619	3,032,544	1,064,653	1,967,891	7,006,846	40,663,296
7	Connecticut			59,918	17,855	42,063	236,075	1,425,959
8	Delaware			39,278	16,187	23,091	45,361	148,467
9	Florida	1,021	8	354,112	181,463	172,649	618,057	2,943,806
10	Georgia	122,610	269	231,145	42,008	189,137	568,067	3,117,358
11	Idaho	43,442	43	676,409	28,103	648,306	1,626,153	8,211,671
12	Illinois	26,016	114	1,543,906	474,477	1,069,429	3,515,833	38,234,410
13	Indian Territory	78,639	541	366,352	249,094	117,258	329,063	4,321,380
14	Indiana	2,164,390	2,678	3,387,668	1,807,948	1,579,720	3,810,666	28,224,760
15	Iowa	48,106	242	373,252	220,698	152,554	961,006	9,676,421
16	Kansas	233,162	306	767,069	384,012	383,057	1,374,545	10,700,285
17	Kentucky	224,923	415	600,613	156,562	444,051	1,207,771	8,588,423
18	Louisiana	105,858	21	25,820	23,207	2,613	7,354	279,327
19	Maine			121,556	12,714	108,842	176,964	3,656,184
20	Maryland	8,499	10	443,170	143,771	299,399	859,755	7,413,712
21	Massachusetts	1,858	7	273,791	44,325	229,466	702,335	4,071,855
22	Michigan	77,047	121	3,869,161	2,311,479	1,557,682	9,341,409	50,157,358
23	Minnesota	339,244	726	4,242,854	3,681,664	561,190	2,868,340	25,729,545
24	Missouri	172,514	441	2,118,436	1,398,827	719,609	2,879,018	20,281,656
25	Montana	64,646	85	893,258	231,774	661,484	5,097,102	28,265,085
26	Nebraska			2,790	823	1,967	11,173	148,391
27	Nevada	7,944	13	177,355	50,003	127,352	623,457	3,518,190
28	New Hampshire			26,993	2,372	24,621	131,128	1,176,342
29	New Jersey	10,770	118	303,669	110,163	193,506	2,295,964	6,605,102
30	New Mexico	48,381	173	140,055	64,438	75,617	497,949	2,086,478
31	New York	355,113	284	1,276,232	369,281	906,951	3,002,554	13,350,421
32	North Carolina	9,000	60	76,842	10,971	65,871	118,782	927,576
33	North Dakota	2,795	9	23,012	1,407	21,605	88,967	334,967
34	Ohio	2,701,657	2,619	7,711,026	4,192,221	3,518,805	10,126,452	57,186,922
35	Oklahoma			15,830	11,667	4,163	31,934	186,706
36	Oregon	19,522	57	143,748	60,499	83,249	408,112	2,087,390
37	Pennsylvania	5,598,074	5,102	23,218,856	10,736,258	12,482,598	33,111,903	290,871,417
38	Rhode Island			25,938	15,143	10,795	85,127	774,611
39	South Carolina			109,880	48,691	61,189	342,379	1,834,134
40	South Dakota	8,349	12	264,452	8,736	255,716	1,992,575	6,769,104
41	Tennessee	174,406	387	720,483	414,367	306,116	850,495	9,583,782
42	Texas	1,387,796	1,098	923,769	295,130	628,639	1,061,457	6,981,782
43	Utah	37,054	136	761,557	41,098	720,459	1,835,658	12,378,350
44	Vermont			382,734	101,546	281,188	1,076,143	5,904,705
45	Virginia	35,964	114	603,290	318,763	284,527	928,387	6,607,807
46	Washington	29,600	30	225,161	56,558	168,603	615,807	5,893,659
47	West Virginia	5,194,279	1,783	7,468,246	3,874,780	3,593,466	8,519,767	48,378,414
48	Wisconsin	3,758	30	427,847	260,375	167,472	804,142	4,427,813
49	Wyoming	15,547	21	280,602	95,222	185,380	818,496	5,684,298

AND TERRITORIES: 1902—Continued.

POWER.														
Total horsepower	Owned										Supplied—			
	Engines.				Water wheels.		Electric motors.		Other power.		To other establishments.	By other establishments.		
	Steam.		Gas or gasoline.									Electric.	Other.	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Horsepower.	Horsepower.	Horsepower.	
¹2,867,502	64,179	2,432,963	13,506	259,665	980	60,897	2,890	190,191	1,102	84,546	2,842	25,556	6,905	1
31,952	436	28,197	10	86			2	35	81	3,629				2
11,283	163	10,124	40	970	1	9	16	612	3	180				3
7,646	177	7,579	3	17			17	972	1	50				4
75,667	1,306	38,788	211	1,675	521	21,694	262	12,982	32	1,715	406	8,825	2,970	5
89,479	1,046	68,182	50	778	77	7,457	309	22,588	109	5,791	363	7,022	249	6
7,965	132	7,775	3	20	3	170								7
1,506	21	1,388	1	8					5	110				8
10,457	307	10,157	2	30	1	270	9	440	3	100				9
9,945	210	7,585	5	61	14	2,050	4	162	14	234		[illegible]		10
19,175	346	9,573	23	1,392	88	7,735	41	2,199	10	472		195		11
95,799	1,329	94,642	21	183			244	5,214	15	972	50		2	12
13,474	178	13,069	1	20			10	515	5	385				13
132,082	1,181	107,770	894	18,971			74	3,823	30	5,176	110		165	14
15,111	578	14,503	34	160	1	10	14	296	8	438	3			15
22,511	369	18,855	38	3,432	1	100	23	872	10	112	34		12	16
20,296	381	18,642	40	440			41	1,849	11	994	150	150	60	17
4,440	7	4,440												18
7,009	182	6,532	4	27	4	380	5	85	3	70	25			19
15,396	184	13,885	7	25	10	465	1	15	37	1,476		45		20
11,337	117	10,776	1	12	4	447	3	70	3	167		35		21
205,442	927	193,878	2	5	20	2,230	126	6,065	94	9,309	20			22
30,229	409	26,936	10	148	5	1,268	15	405	44	1,332	140	305	140	23
51,965	1,272	48,978	19	259	3	80	69	2,047	41	2,399	61	77	192	24
67,273	458	57,938	10	355	24	1,063	89	4,058	49	4,607	87	1,956	804	25
296	8	292	1	4										26
4,826	50	2,923	18	344	21	1,467	27	1,106	1	40		51	1	27
2,617	93	2,580	2	27	1	10	6	80						28
21,508	266	20,868			2	95	12	427	7	150		495		29
8,808	129	7,897	19	306	7	504	35	1,667	4	101				30
84,699	2,936	74,547	266	5,461	52	3,114	109	3,229	4	130		1,297	150	31
3,954	100	3,111			7	635	5	120	4	208				32
964	22	964					12	86						33
210,901	7,396	153,950	3,292	55,362	3	42	158	6,495	17	1,313		137	97	34
494	8	494												35
3,791	71	2,539	8	121	31	1,101	14	666	1	30				36
1,179,776	29,631	983,112	8,299	164,625	14	825	678	61,505	338	29,752	575	1,462		37
1,486	63	1,414	1	12					2	50		10		38
4,833	118	4,773					1	35	3	60				39
14,190	86	12,687	1	8	1	70	5	86	10	1,425				40
14,502	197	12,298	16	109			15	865	58	2,095				41
13,058	347	10,446	28	521			1	40	35	1,039	262		1,052	42
15,618	142	12,573	6	209	12	1,116	63	4,177	18	578		1,141	1	43
15,209	265	11,526			18	3,323	16	1,845	5	230		130		44
18,847	268	17,048	3	46	12	1,065	48	1,910	18	688	315			45
12,109	125	10,566	3	49	15	1,240	79	2,185	5	189	125	25	10	46
244,267	9,875	236,008	86	1,097			217	16,894	20	5,917	70	215		47
12,774	212	11,829	25	360	6	515	4	31	9	63		7		48
20,796	148	18,086	1	10			24	1,079	15	2,700				49

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[1] Includes electric and other horsepower "supplied by other establishments," but does not include horsepower of electric motors owned.

DETAILED SUMMARY, STATES AND TERRITORIES, BY MINERALS

TABLE 3.—DETAILED SUMMARY, STATES

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.					
						Total.		Men 16 years and over.		Boys under 16 years.	
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
1	United States	151,516	46,858	38,128	$39,020,532	581,728	$369,959,960	569,871	$367,071,593	11,857	$2,888,367
2	Alabama	259	172	945	979,117	19,132	10,345,148	18,502	10,173,247	630	171,901
3	Clay	5	5			33	9,634	33	9,634		
4	Coal, bituminous	145	91	623	709,449	12,930	7,841,457	12,462	7,693,918	468	147,539
5	Gold and silver	1	4	7	6,710	34	12,182	34	12,182		
6	Iron ore	59	31	227	188,441	4,864	2,029,807	4,738	2,009,431	126	20,376
7	Limestones and dolomites	33	29	65	54,597	1,002	354,718	979	351,002	23	3,716
8	Sandstones and quartzites	7	7	6	2,650	58	30,523	58	30,523		
9	All other minerals[2]	7	5	21	17,270	211	66,827	198	66,557	13	270
10	Arizona	113	158	445	710,183	5,328	5,059,065	5,278	5,032,045	50	27,020
11	Copper ore	30	30	258	399,275	3,797	3,497,528	3,747	3,470,508	50	27,020
12	Gold and silver	74	74	169	283,023	1,442	1,498,251	1,442	1,498,251		
13	Sandstones and quartzites	1	4	9	16,775	32	24,922	32	24,922		
14	All other minerals[3]	5	50	9	11,100	57	38,364	57	38,364		
15	Arkansas	120	131	210	191,528	2,944	1,945,479	2,892	1,933,990	52	11,489
16	Bauxite	19	3	13	10,875	30	14,504	28	14,154	2	350
17	Coal, bituminous	53	33	146	148,113	2,574	1,780,061	2,527	1,769,397	47	10,664
18	Limestones and dolomites	13	12	16	7,864	119	43,680	118	43,530	1	150
19	Oilstones, whetstones, and scythestones	4	3	2	1,050	23	10,615	23	10,615		
20	Sandstones and quartzites	18	17	11	5,806	111	52,170	111	52,170		
21	Siliceous crystalline rocks	3	3	2	1,650	10	4,260	10	4,260		
22	All other minerals[4]	10	60	20	16,170	77	40,189	75	39,864	2	325
23	California	4,037	1,552	1,432	1,937,980	12,964	11,050,666	12,945	11,044,302	19	6,364
24	Asphaltum and bituminous rock	9	9	3	8,280	32	20,031	32	20,031		
25	Borax	4	4	10	14,778	141	108,525	141	108,525		
26	Clay	6	6	4	3,558	17	11,680	17	11,680		
27	Coal, bituminous[5]	10	10	27	85,098	182	126,553	180	126,073	2	480
28	Copper ore	7	7	38	48,033	496	445,247	496	445,247		
29	Gold and silver	1,020	1,020	748	1,049,846	7,989	7,101,003	7,982	7,098,869	7	2,134
30	Limestones and dolomites	17	14	7	9,400	281	163,130	281	163,130		
31	Manganese ore	3	3			7	4,740	7	4,740		
32	Marble	5	5	13	9,297	50	39,951	48	39,030	2	921
33	Natural gas	29	15	10	14,040	21	10,800	21	10,800		
34	Petroleum	2,757	290	384	452,320	1,112	1,087,839	1,112	1,087,839		
35	Precious stones	31	47	7	9,097	19	12,591	19	12,591		
36	Quicksilver	36	34	98	134,278	1,096	793,926	1,094	793,141	2	785
37	Sandstones and quartzites[8]	15	11	8	11,840	363	269,433	363	269,433		
38	Siliceous crystalline rocks	64	62	38	46,054	920	687,638	917	686,684	3	954
39	All other minerals[9]	24	15	37	42,061	238	167,559	235	166,479	3	1,080
40	Colorado	1,147	1,011	1,898	2,663,333	20,519	18,874,818	20,422	18,840,583	97	34,235
41	Clay	1	1	3	2,460	50	32,612	50	32,612		
42	Coal, bituminous	129	80	611	818,445	7,955	6,006,185	7,861	5,973,270	94	32,915
43	Copper ore	18	18	25	17,338	115	108,981	115	108,981		
44	Gold and silver	772	772	1,148	1,687,518	11,200	11,726,123	11,199	11,725,543	1	580
45	Iron ore	33	23	33	42,577	418	417,162	418	417,162		
46	Lead and zinc ore	3	3	3	2,025	5	5,475	5	5,475		
47	Limestones and dolomites	11	9	6	6,566	188	127,747	186	127,007	2	740
48	Petroleum	111	12	23	43,055	147	138,436	147	138,436		
49	Sandstones and quartzites	51	47	33	28,704	343	237,905	343	237,905		
50	Siliceous crystalline rocks	10	10	7	6,345	46	34,092	46	34,092		
51	Uranium and vanadium	3	3	2	3,500	19	17,040	19	17,040		
52	All other minerals[11]	5	33	4	4,800	33	23,060	33	23,060		
53	Connecticut	90	78	151	132,096	1,497	808,772	1,490	807,167	7	1,605
54	Crystalline quartz	4	5	8	6,030	18	8,792	18	8,792		
55	Feldspar	6	6	8	5,345	71	33,672	71	33,672		
56	Flint	4	1	2	1,200	10	4,835	10	4,835		
57	Limestones and dolomites	12	7	18	18,890	135	66,765	135	66,765		
58	Sandstones and quartzites	7	7	15	13,554	142	73,939	142	73,939		
59	Siliceous crystalline rocks	49	14	87	75,082	943	535,334	936	533,729	7	1,605
60	All other minerals[12]	8	7	13	11,451	178	85,435	178	85,435		
61	Delaware	12	12	29	28,047	504	222,622	496	220,122	8	2,500
62	Clay	6	6	13	12,740	169	69,472	169	69,472		
63	Siliceous crystalline rocks	6	6	16	15,307	335	153,150	327	150,650	8	2,500
64	Florida	71	46	218	228,568	3,146	1,082,030	3,107	1,075,781	39	6,249
65	Limestones and dolomites	6	6	3	2,110	87	28,054	87	28,054		
66	Phosphate rock	61	36	192	206,108	2,866	996,801	2,850	994,052	16	2,749
67	All other minerals[13]	4	4	23	20,350	193	57,175	170	53,675	23	3,500

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[1] Long tons.

[2] Includes operators as follows: Bauxite, 1 (3 mines); cement, 1; graphite, 1; marble, 1; sulphur and pyrite, 1.

[3] Includes operators as follows: Fluorspar, 2; lead and zinc ore, 1; precious stones, 46 (1 mine); siliceous crystalline rocks, 1.

[4] Includes operators as follows: Asphaltum and bituminous rock, 1; fuller's earth, 2; gold and silver, 1; manganese ore, 2; marble, 1; mineral pigments, crude, 1; phosphate rock, 1; precious stones, 50 (no mines); slate, 1.

[5] Includes 2 operators in Alaska.

[6] Barrels of 42 gallons.

[7] Quicksilver, 28,972 flasks (76½ pounds each) and 10,427 short tons of cinnabar.

[8] Includes 1 operator in Hawaii.

[9] Includes operators as follows: Cement, 2; chrome ore, 1; gypsum, 1; infusorial earth, tripoli, and pumice, 1; lithium ore, 2; magnesite, 1; mica, 1 (0 mines); mineral pigments, crude, 2; slate, 1; talc and soapstone, 1; sulphur and pyrite, 2.

AND TERRITORIES, BY MINERALS: 1902.

WAGE EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.		
Above ground.		Below ground.										
Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		Quantity (short tons).	Value.	
221,505	$125,096,530	500,223	$244,873,490	$20,677,938	21,183	$71,771,713	$34,530,713	$37,241,000	$123,914,967	....	$796,826,417	1
6,001	2,477,581	13,131	7,967,567	267,279	1,420	858,851	195,045	663,806	2,043,914	....	17,367,992	2
33	9,634	....	....	....	....	3,866	3,785	81	1,903	40,065	19,742	3
1,567	804,110	11,353	7,097,347	265,579	1,411	734,972	149,013	585,959	1,219,410	10,454,570	12,419,666	4
12	4,890	22	7,292	1,200	2	824	....	824	5,216	....	1,057	5
3,134	1,213,629	1,741	846,178	500	7	88,008	37,938	50,070	592,286	[1]3,574,474	3,930,812	6
1,002	354,718	....	....	....	....	25,954	2,079	23,875	149,012	....	759,617	7
58	30,623	....	....	....	....	1,535	1,480	55	5,290	....	42,706	8
196	60,077	15	6,750	....	....	3,692	750	2,942	70,867	....	188,392	9
1,720	1,647,840	3,603	3,411,225	159,942	179	392,495	18,567	373,928	3,060,521	....	11,197,375	10
1,178	1,072,028	2,619	2,425,560	122,337	121	256,753	7,679	249,074	2,185,676	....	8,279,224	11
459	513,076	983	985,175	37,605	58	114,046	2,888	111,158	873,091	....	2,704,677	12
32	24,922	....	....	....	....	9,005	....	9,005	50,220	....	107,910	13
51	87,814	1	550	....	....	12,691	8,000	4,691	1,534	....	45,564	14
812	409,741	2,132	1,565,738	860	13	95,481	40,818	54,663	244,379	....	2,840,341	15
30	14,501	....	....	375	8	4,175	....	4,175	10,602	[1]4,645	13,920	16
454	253,303	2,130	1,526,558	485	5	82,949	39,533	43,416	177,716	1,948,932	2,539,214	17
119	43,680	....	....	....	....	1,716	....	1,716	32,579	....	113,163	18
25	10,615	....	....	....	....	685	175	510	1,625	500	21,275	19
111	52,170	....	....	....	....	1,530	350	1,180	7,915	....	85,917	20
10	4,260	....	....	....	....	945	760	185	650	....	12,115	21
65	31,009	12	9,180	....	....	3,481	....	3,481	13,292	....	54,737	22
6,319	5,326,422	6,645	5,724,244	520,894	604	1,783,790	685,982	1,097,808	5,673,765	....	28,870,405	23
32	20,031	....	....	....	....	1,185	800	385	1,350	45,377	101,358	24
64	46,471	77	62,104	....	....	46,206	19,200	27,006	210,729	16,950	2,370,994	25
17	11,680	....	....	....	....	1,656	1,656	....	910	23,483	24,445	26
61	42,249	121	84,304	2,900	19	8,377	3,000	5,377	45,000	87,196	273,398	27
111	105,236	385	340,011	....	....	15,367	1,200	14,167	211,164	....	1,599,003	28
2,625	2,110,549	5,514	4,690,454	47,066	145	967,755	403,990	563,765	2,966,102	....	15,473,091	29
281	163,130	....	....	1,000	10	15,790	8,825	6,965	111,564	....	521,093	30
2	1,500	5	3,200	....	....	50	....	50	461	[1]846	10,175	31
50	39,951	....	....	....	....	6,487	900	5,587	10,317	....	92,298	32
21	16,800	....	....	12,300	2	15,737	....	15,737	13,698	....	120,648	33
1,112	1,067,889	....	....	431,699	352	571,138	214,261	356,877	1,479,528	[1]13,984,268	4,873,617	34
12	6,937	7	5,664	....	....	1,568	....	1,568	7,113	....	65,000	35
425	304,089	651	488,827	22,920	75	53,462	7,078	46,384	248,594	....	1,299,740	36
568	289,438	....	....	....	....	14,758	6,130	8,628	50,967	....	469,016	37
920	687,658	....	....	....	....	39,232	18,039	21,193	115,420	....	1,137,679	38
173	117,870	25	19,700	....	....	25,022	903	24,119	170,500	....	442,195	39
5,728	5,422,100	14,791	13,475,755	793,985	610	3,052,544	1,064,653	1,987,891	7,006,846	....	40,603,286	40
14	8,950	36	23,092	7,450	16	7,637	7,314	323	5,608	75,913	67,434	41
1,788	1,207,900	6,367	4,748,285	14,413	98	681,494	228,376	453,118	1,039,831	7,401,343	8,397,812	42
25	22,368	92	84,663	965	3	4,648	360	4,248	58,221	....	71,411	43
3,285	3,556,482	7,915	8,160,641	360,707	473	2,156,217	715,309	1,440,908	5,603,452	....	29,[illegible],974	44
56	61,189	362	355,275	....	....	114,510	87,094	27,416	157,150	[illegible]	1,084,424	45
1	1,125	4	4,500	500	1	890	....	890	3,000	[1]1,636	22,298	46
188	127,747	....	....	....	....	5,886	2,907	2,979	21,440	....	203,710	47
147	139,430	....	....	9,650	28	40,163	18,497	21,666	68,708	336,901	484,683	48
586	287,905	....	....	....	....	12,089	4,631	7,458	36,196	....	366,161	49
46	31,082	....	....	....	....	2,870	65	2,805	4,730	....	66,023	50
5	3,576	14	13,464	....	....	490	....	490	3,010	5,840	48,125	51
52	22,440	1	720	....	....	6,000	....	6,000	45,210	....	135,141	52
1,457	786,446	60	22,326	....	....	59,958	17,866	42,063	236,075	....	1,425,950	53
18	8,792	....	....	....	....	1,450	1,325	125	700	10,300	32,075	54
71	33,672	....	....	....	....	4,564	3,854	710	20,677	[14]13,949	73,764	55
10	4,856	....	....	....	....	675	520	155	1,965	[14]1,812	11,575	56
135	66,765	....	....	....	....	9,028	1,320	7,708	64,546	....	205,371	57
142	73,939	....	....	....	....	6,881	95	6,786	14,068	....	128,579	58
943	535,834	....	....	....	....	31,869	8,308	23,561	118,250	....	812,141	59
118	63,109	60	22,326	....	....	3,461	2,433	1,028	25,488	....	162,454	60
437	196,969	67	25,653	....	....	38,278	15,187	23,091	45,361	....	448,467	61
102	48,819	67	25,653	....	....	19,590	8,589	11,001	27,235	123,319	171,714	62
335	153,150	....	....	....	....	19,698	7,598	12,100	18,126	....	276,753	63
3,118	1,073,550	28	8,500	4,021	8	404,142	231,493	172,649	618,067	....	2,943,806	64
87	28,654	....	....	....	....	2,208	1,350	858	14,769	....	63,571	65
2,858	994,206	8	2,500	....	....	383,149	220,143	163,006	542,322	[15]786,115	2,655,463	66
173	51,175	20	6,000	4,021	8	18,785	10,000	8,785	60,966	....	224,772	67

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[10] Includes 100 short tons of lead ore and 1,536 short tons of zinc ore.
[11] Includes operators as follows: Cement, 3; gypsum, 1; natural gas, 3; precious stones, 2 (no mines); tungsten, 5.
[12] Includes 5,207 tons of crude.
[13] Includes 852 tons of crude.
[14] Includes operators as follows: Asbestos, 1; clay, 2; garnet, 2; iron ore, 1 (2 mines); marble, 1; tungsten, 1.
[15] Includes operators as follows: Clay, 2; fuller's earth, 2.

TABLE 3.—DETAILED SUMMARY, STATES AND

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.					
						Total.		Men 16 years and over.		Boys under 16 years.	
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
68	Georgia	149	127	304	$209,281	2,820	$1,085,047	2,723	$1,071,985	97	$13,062
69	Bauxite	16	3	23	10,335	93	36,550	92	36,450	1	100
70	Clay	7	7	19	12,320	136	37,333	129	36,209	7	1,124
71	Coal, bituminous	3	2	24	20,326	168	74,649	168	74,649		
72	Gold and silver	45	45	59	29,508	334	107,718	331	107,328	3	390
73	Iron ore	19	13	60	42,361	658	229,138	617	223,346	41	5,792
74	Limestones and dolomites	8	8	15	6,752	152	42,516	149	42,192	3	324
75	Manganese ore	6	6	7	2,964	62	21,161	53	20,207	9	954
76	Marble	5	5	21	23,050	310	105,709	304	104,869	6	840
77	Mineral pigments, crude	1	1	8	5,134	65	19,471	65	19,471		
78	Siliceous crystalline rocks	26	24	45	34,586	724	382,559	700	379,281	24	3,278
79	All other minerals[2]	10	10	20	12,975	88	28,234	85	27,974	3	260
80	Idaho	292	290	354	576,690	3,563	3,903,504	3,560	3,902,812	3	692
81	Gold and silver	258	258	340	550,548	3,382	3,698,345	3,379	3,697,653	3	692
82	Limestones and dolomites	14	13			6	3,964	6	3,964		
83	Sandstones and quartzites	11	10	1	1,232	7	4,655	7	4,655		
84	All other minerals[3]	9	9	13	24,910	168	196,540	168	196,540		
85	Illinois	1,116	1,013	1,869	1,910,940	40,523	26,986,397	39,597	26,707,071	926	279,326
86	Cement	6	6	50	59,250	188	261,926	188	261,926		
87	Clay	8	7	2	1,200	12	19,692	12	19,692		
88	Coal, bituminous	875	789	1,510	1,564,832	36,617	24,876,201	35,705	24,599,993	912	276,208
89	Fluorspar	5	5	9	5,304	71	28,845	71	28,845		
90	Lead and zinc ore	14	14	12	9,130	104	51,565	103	51,390	1	175
91	Limestones and dolomites	160	150	284	270,025	3,178	1,737,363	3,165	1,734,420	13	2,943
92	Natural gas[6]	31	24			1	600	1	600		
93	Sandstones and quartzites	18	18	2	1,200	22	10,295	22	10,295		
94	Indian Territory	79	39	260	253,171	1,814	3,183,322	1,688	3,146,854	126	36,468
95	Asphaltum and bituminous rock	6	6	5	4,410	28	13,185	28	13,185		
96	Coal, bituminous	58	29	248	240,581	1,763	3,154,267	1,637	3,117,799	126	36,468
97	All other minerals[7]	15	4	7	8,180	23	15,870	23	15,870		
98	Indiana	16,825	3,909	1,662	1,430,538	16,473	10,729,767	16,294	10,678,201	179	51,566
99	Cement	9	7	65	71,166	568	256,949	567	256,718	1	231
100	Coal, bituminous	339	283	637	530,192	10,593	7,896,425	10,468	7,858,450	125	37,975
101	Limestones and dolomites	160	156	266	258,186	2,834	1,399,829	2,783	1,387,072	51	12,757
102	Natural gas	6,861	880	580	447,508	938	586,860	938	586,860		
103	Petroleum	9,439	2,567	108	138,536	1,463	1,045,925	1,463	1,045,925		
104	Sandstones and quartzites	9	9	6	4,650	41	19,567	40	19,339	1	228
105	All other minerals[9]	8	7			36	14,212	35	13,837	1	375
106	Iowa	625	589	616	500,126	10,467	6,791,161	10,293	6,737,944	174	53,217
107	Coal, bituminous	329	299	512	436,828	9,439	6,251,732	9,274	6,200,926	165	50,806
108	Gypsum	9	3	26	15,883	293	170,828	293	170,828		
109	Lead and zinc ore	11	14	1	290	13	5,766	13	5,766		
110	Limestones and dolomites	244	241	76	46,775	680	357,249	671	354,838	9	2,411
111	Sandstones and quartzites	32	32	1	360	12	5,586	12	5,586		
112	Kansas	1,259	398	563	527,242	8,726	5,680,593	8,684	5,668,026	42	12,567
113	Coal, bituminous	175	132	367	345,162	7,017	4,719,595	6,983	4,709,228	34	10,367
114	Lead and zinc ore	57	57	35	21,143	223	140,249	223	140,249		
115	Limestones and dolomites	115	115	32	20,011	566	288,347	566	288,347		
116	Natural gas	414	57	43	32,012	100	65,952	98	65,327	2	625
117	Petroleum	470	12	31	31,664	146	108,756	146	108,756		
118	Sandstones and quartzites	19	18	3	3,400	137	67,260	135	66,885	2	375
119	All other minerals[10]	9	7	52	73,850	537	290,484	533	289,284	4	1,200
120	Kentucky	1,142	675	851	666,360	10,654	5,193,792	10,427	5,147,668	227	46,124
121	Asphaltum and bituminous rock	5	5	32	17,420	65	22,571	65	22,571		
122	Clay	5	5	1	3,200	38	17,080	38	17,080		
123	Coal, bituminous	523	503	560	476,508	9,077	4,522,207	8,859	4,477,522	218	44,685
124	Fluorspar	14	20	31	21,107	193	79,107	191	78,873	2	234
125	Limestones and dolomites	70	69	68	48,406	774	319,700	768	318,545	6	1,155
126	Natural gas	117	19	22	34,240	50	27,560	50	27,560		
127	Petroleum	392	50	65	44,376	79	69,189	79	69,189		
128	Sandstones and quartzites	9	9	16	10,270	166	63,589	165	63,539	1	50
129	All other minerals[11]	7	6	55	10,824	202	72,786	202	72,786		
130	Louisiana	8	3	8	7,593	61	34,444	61	34,444		
131	All minerals[14]	8	3	8	7,593	61	34,444	61	34,444		

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[1] Long tons.

[2] Includes operators as follows: Asbestos, 1; cement, 2; graphite, 2; infusorial earth, tripoli and pumice (operator reported under talc and soapstone), mica, 1; sandstones and quartzites, 1; slate, 1; talc and soapstone, 1; sulphur and pyrite, 1.

[3] Includes operators as follows: Coal, bituminous, 5; copper ore, 1; precious stones, 1; siliceous crystalline rocks, 2.

[4] Barrels.

[5] Includes 792 short tons of lead ore and 2,778 short tons of zinc ore.

[6] Includes 1 operator (2 wells) for petroleum.

[7] Includes operators as follows: Natural gas, 1; petroleum, 2 (13 wells); siliceous crystalline rocks, 1.

[8] Barrels of 42 gallons.

TERRITORIES, BY MINERALS: 1902—Continued.

WAGE-EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.		
Above ground.		Below ground.										
Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		Quantity (short tons).	Value.	
2,401	$927,338	419	$157,709	$122,610	569	$231,145	$42,008	$189,137	$566,067	....	$3,117,358	68
98	36,550	....	....	125	2	9,564	1,340	8,224	23,917	[1]20,644	96,194	69
136	37,333	....	....	....	....	3,017	100	2,917	15,500	18,595	76,180	70
76	36,262	92	38,387	121,464	563	18,319	....	18,319	107,994	414,083	599,018	71
187	56,894	147	50,824	1,090	4	9,684	3,486	6,198	33,123	....	149,150	72
538	170,318	152	56,620	....	....	76,622	8,351	68,271	64,932	[1]330,554	452,717	73
152	42,516	....	....	....	....	3,348	2,527	821	17,905	....	111,589	74
50	17,561	12	3,600	....	....	2,915	1,575	1,340	6,860	[1]3,500	20,800	75
310	105,709	....	....	....	....	68,557	15,412	53,145	77,205	....	600,517	76
54	15,693	11	3,778	....	....	1,713	....	1,713	13,146	5,698	48,423	77
724	382,559	....	....	....	....	32,588	8,701	23,887	188,278	....	803,778	78
83	25,934	5	2,300	....	....	4,818	516	4,302	17,201	....	108,662	79
938	1,003,812	2,625	2,899,692	43,442	43	636,409	28,103	608,306	1,626,153	....	5,211,671	80
868	930,418	2,514	2,767,927	41,642	38	614,670	28,047	586,623	1,605,696	....	5,177,267	81
6	3,964	....	....	....	....	110	....	110	1,265	....	15,074	82
7	1,655	....	....	....	....	615	6	609	352	....	13,777	83
57	64,775	111	131,765	1,800	5	21,014	50	20,964	18,840	....	8,553	84
7,500	4,503,887	33,023	22,482,510	26,016	141	1,543,903	474,475	1,069,428	8,515,928	....	28,234,410	85
484	258,676	4	3,250	....	....	35,621	....	35,621	185,881	[4]1,058,081	769,251	86
36	17,075	6	2,527	....	....	1,999	1,035	964	3,916	52,152	38,163	87
3,713	2,449,583	32,904	22,436,618	24,699	132	1,258,686	425,705	832,981	2,834,444	32,939,373	33,945,910	88
38	15,328	33	13,517	....	....	1,149	250	899	17,115	18,860	123,000	89
28	14,967	76	36,598	....	....	11,079	9,853	1,226	30,464	[5]3,570	90,619	90
3,178	1,737,393	....	....	....	....	233,379	36,439	196,940	451,908	....	3,232,123	91
1	600	....	....	1,317	12	44	....	44	150	....	2,844	92
22	10,295	....	....	....	....	1,946	1,193	753	1,955	....	32,200	93
787	457,881	4,027	2,725,441	78,639	541	366,332	249,034	117,298	329,063	....	1,321,380	94
26	11,922	2	1,263	1,029	6	2,213	796	1,417	6,299	2,566	11,754	95
738	430,089	4,025	2,724,178	56,610	520	358,960	244,439	114,521	320,664	2,820,666	1,265,106	96
23	15,870	....	....	21,000	15	5,159	3,799	1,360	2,100	....	44,520	97
6,907	3,989,236	9,566	6,740,531	2,164,380	2,678	3,387,668	1,807,948	1,579,720	3,810,666	....	28,224,760	98
581	253,163	37	13,786	....	....	53,447	....	53,447	430,168	[4]1,879,891	1,296,228	99
1,064	669,680	9,529	6,726,745	26,603	101	449,054	215,458	233,596	729,104	9,446,424	10,389,660	100
2,884	1,399,829	....	....	....	....	196,907	17,273	179,634	499,764	....	2,865,691	101
838	586,860	....	....	1,046,444	1,267	1,399,355	539,844	859,511	1,028,358	....	7,081,344	102
1,463	1,045,925	....	....	1,091,333	1,310	1,286,499	1,034,070	252,429	1,126,627	[8]7,480,886	6,526,622	103
41	19,567	....	....	....	....	1,706	928	778	5,040	....	37,593	104
36	14,212	....	....	....	....	700	375	325	3,605	....	27,622	105
1,942	1,103,314	8,496	5,687,847	48,106	242	373,252	220,698	152,554	961,996	....	9,676,424	106
1,095	651,915	8,344	5,599,817	48,046	240	341,191	211,275	129,916	841,506	5,904,766	8,660,287	107
149	86,020	144	84,808	....	....	6,505	1,088	5,417	47,683	130,779	337,734	108
6	2,544	7	3,222	....	....	2,511	1,955	556	919	[10]561	13,358	109
680	357,249	....	....	60	2	22,518	6,108	16,410	71,361	....	649,984	110
12	5,586	....	....	....	....	527	272	255	527	....	15,061	111
2,399	1,329,558	6,367	4,351,065	213,182	366	767,069	384,012	383,057	1,374,565	....	10,700,285	112
780	441,841	6,232	4,277,754	3,644	106	418,921	173,770	245,151	596,501	5,266,065	6,862,787	113
129	80,267	108	60,016	922	11	151,279	140,736	10,543	84,313	[11]25,110	737,656	114
566	288,947	....	....	300	6	21,378	11,089	10,289	51,342	....	670,586	115
100	65,952	....	....	107,968	128	40,109	21,038	19,071	165,850	....	824,431	116
146	108,756	....	....	99,467	105	51,054	28,255	22,799	296,821	[8]331,740	202,464	117
137	67,260	....	....	....	....	5,790	2,367	3,423	13,944	....	105,509	118
510	277,199	27	13,235	881	10	75,538	3,757	71,781	165,755	....	1,206,902	119
2,781	1,246,322	7,873	3,917,460	224,923	315	600,613	156,262	444,061	1,297,771	....	8,583,423	120
65	22,574	....	....	....	....	11,948	....	11,948	7,353	22,496	68,704	121
48	17,080	....	....	4,000	15	1,546	897	649	10,250	26,062	44,256	122
1,299	614,147	7,778	3,907,760	10,668	73	285,792	79,189	206,603	748,313	6,760,964	6,666,967	123
98	39,107	95	39,700	300	3	22,328	7,650	14,678	18,952	29,000	143,410	124
774	319,709	....	....	900	8	14,143	6,161	7,982	54,809	....	593,747	125
50	27,570	....	....	9,297	22	112,794	8,725	104,069	57,197	....	365,611	126
79	19,189	....	....	194,462	174	147,205	53,613	93,592	227,822	[4]248,950	172,807	127
166	63,389	....	....	....	....	928	27	901	10,165	....	128,470	128
202	72,786	....	....	5,296	20	3,539	....	3,539	102,910	....	349,121	129
61	34,444	....	....	105,856	21	25,820	23,207	2,613	7,354	....	279,327	130
61	34,444	....	....	105,856	21	25,820	23,207	2,613	7,354	....	279,327	131

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[9] Includes operators as follows: Clay, 2; oilstones, whetstones, and scythestones, 5 (6 mines); sulphur and pyrite (operator reported under coal, bituminous).

[10] Includes 186 short tons of lead ore and 375 short tons of zinc ore.

[11] Includes 3,468 short tons of lead ore and 21,642 short tons of zinc ore.

[12] Includes operators as follows: Cement, 2; gypsum, 5 (7 quarries).

[13] Includes operators as follows: Cement, 1 (2 quarries); iron ore, 3; lead and zinc ore, 1; oilstones, whetstones, and scythestones, 1.

[14] Includes operators as follows: Petroleum, 2 (7 wells); sulphur and pyrite, 1.

TABLE 3.—DETAILED SUMMARY, STATES AND

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.					
						Total.		Men 16 years and over.		Boys under 16 years.	
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
132	Maine	135	141	208	$193,814	3,684	$2,284,789	3,650	$2,274,518	34	$10,271
133	Limestones and dolomites	11	11	16	13,236	621	288,512	621	288,512		
134	Siliceous crystalline rocks	110	103	163	158,516	2,832	1,867,200	2,798	1,856,929	34	10,271
135	Slate	7	7	22	16,999	217	110,818	217	110,818		
136	All other minerals[1]	7	20	7	5,063	14	18,259	14	18,259		
137	Maryland	232	209	398	465,665	6,826	4,523,939	6,651	4,473,555	175	50,384
138	Cement	4	4	22	17,227	170	74,677	169	74,477	1	200
139	Clay	6	6	1	300	21	4,556	21	4,556		
140	Coal, bituminous	44	30	210	315,791	4,936	3,468,117	4,807	3,426,337	129	41,780
141	Flint	6	5	14	11,090	65	21,383	65	21,383		
142	Iron ore	29	28	5	1,910	76	22,349	64	20,204	12	2,145
143	Limestones and dolomites	102	100	53	31,299	430	159,793	419	157,865	11	1,928
144	Mineral pigments, crude	4	4			4	1,716	4	1,716		
145	Sandstones and quartzites	5	5	2	1,148	12	5,394	11	5,232	1	162
146	Siliceous crystalline rocks	17	15	65	67,925	817	435,372	802	432,404	15	2,968
147	Slate	6	6	10	4,520	145	72,179	140	71,090	5	1,089
148	All other minerals[4]	9	8	16	14,475	150	58,403	149	58,291	1	112
149	Massachusetts	251	234	360	309,978	4,242	2,525,405	4,220	2,519,679	22	5,726
150	Limestones and dolomites	11	8	17	12,606	293	99,740	293	99,740		
151	Marble	8	8	13	12,468	190	72,730	190	72,730		
152	Sandstones and quartzites	19	15	35	25,586	342	222,977	342	222,977		
153	Siliceous crystalline rocks	204	194	279	248,512	3,395	2,045,340	3,373	2,039,614	22	5,726
154	All other minerals[5]	9	9	16	10,856	172	84,618	172	84,618		
155	Michigan	203	146	1,585	1,840,132	31,951	20,103,616	31,897	20,084,501	54	19,115
156	Cement	11	10	102	131,131	938	535,570	938	535,570		
157	Coal, bituminous	31	30	99	87,780	1,145	1,075,805	1,143	1,075,228	2	577
158	Copper ore	29	29	419	598,076	13,887	8,744,992	13,850	8,731,087	37	13,905
159	Gypsum	6	4	127	171,245	359	176,607	359	176,607		
160	Iron ore	80	41	750	775,914	11,456	9,132,763	11,446	9,129,270	10	3,493
161	Limestones and dolomites	30	29	62	49,264	695	325,379	693	324,779	2	600
162	Sandstones and quartzites	9	8	21	23,470	151	86,108	148	85,468	3	640
163	All other minerals[7]	16	4	5	3,252	50	26,392	50	26,392		
164	Minnesota	176	255	675	577,336	9,760	6,891,184	9,753	6,889,657	7	1,527
165	Iron ore	59	31	529	430,904	8,256	5,876,933	8,254	5,876,820	2	113
166	Limestones and dolomites[6]	77	76	92	86,969	785	481,561	781	480,546	4	1,015
167	Precious stones		110								
168	Sandstones and quartzites	13	12	18	18,654	305	215,068	305	215,068		
169	Siliceous crystalline rocks	27	25	36	40,719	414	317,622	413	317,553	1	69
170	Missouri	1,015	973	1,438	1,233,811	15,351	8,757,367	15,238	8,729,776	113	27,591
171	Barytes	34	28	4	670	239	99,799	239	99,799		
172	Clay	25	25	20	10,115	120	66,169	120	66,169		
173	Coal, bituminous	384	345	420	325,147	6,501	3,927,158	6,436	3,909,657	65	17,501
174	Iron ore	24	27	15	14,766	148	57,475	147	57,305	1	170
175	Lead and zinc ore	373	374	777	727,121	6,612	3,691,923	6,584	3,685,773	28	6,150
176	Limestones and dolomites	142	136	155	129,291	1,434	752,178	1,424	749,627	10	2,551
177	Natural gas	13	9	1	232						
178	Sandstones and quartzites	10	10	7	3,375	56	31,989	55	31,865	1	124
179	Siliceous crystalline rocks	11	9	16	11,614	179	104,624	171	103,529	8	1,095
180	All other minerals[10]	18	10	25	11,580	62	26,052	62	26,052		
181	Montana	281	271	571	912,477	10,539	11,812,150	10,530	11,809,062	9	3,088
182	Coal, bituminous	37	31	61	80,674	1,587	1,516,043	1,578	1,512,955	9	3,088
183	Copper ore	27	27	310	494,415	6,388	7,339,773	6,388	7,339,773		
184	Gold and silver	176	176	185	318,169	2,278	2,688,052	2,278	2,688,052		
185	Limestones and dolomites	10	10	4	1,091	91	70,078	91	70,078		
186	Precious stones	3	3	2	1,759	39	43,664	39	43,664		
187	Sandstones and quartzites	8	8	2	3,900	57	52,117	57	52,117		
188	Siliceous crystalline rocks	3	3	1	1,420	21	26,488	21	26,488		
189	All other minerals[11]	17	10	6	8,227	78	75,935	78	75,935		
190	Nebraska	36	35	12	8,001	178	95,935	176	95,320	2	615
191	All minerals[12]	36	35	12	8,001	178	95,935	176	95,320	2	615
192	Nevada	114	121	146	222,098	1,132	1,205,565	1,130	1,205,025	2	540
193	Gold and silver	104	104	136	210,838	1,075	1,162,337	1,073	1,161,797	2	540
194	Sandstones and quartzites	3	3			2	1,583	2	1,583		
195	All other minerals[13]	7	14	10	11,260	55	41,645	55	41,645		

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[1] Includes operators as follows: Feldspar, 5, flint (operator reported under feldspar); mica, 2; precious stones, 13 (no mines).

[2] Barrels.

[3] Includes 1,995 short tons crude.

[4] Includes operators as follows: Feldspar, 2 (3 mines); gold and silver, 1; infusorial earth, tripoli, and pumice, 1; marble, 2; talc and soapstone, 2.

[5] Includes operators as follows: Asbestos, 1; clay, 1; corundum and emery, 1; feldspar (operator reported under flint); flint, 1; graphite, 1; infusorial earth, tripoli, and pumice, 1; iron ore, 1; sulphur and pyrite, 1; talc and soapstone, 1.

[6] Long tons.

[7] Includes operators as follows: Clay, 1; graphite, 2; grindstones and pulpstones (operator reported under sandstones and quartzites); oilstones, whetstones, and scythestones (operator reported under sandstones and quartzites); petroleum, 1 (13 wells).

TERRITORIES, BY MINERALS: 1902—Continued.

WAGE-EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.				PRODUCT.		
Above ground.		Below ground.										
Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.	Cost of supplies and materials.	Quantity (short tons).	Value.	
3,683	$2,284,414	1	$375			$121,556	$12,714	$108,842	$476,961		$3,656,134	132
571	288,512					37,613	5,248	32,365	225,604		745,132	133
2,852	1,867,200					66,413	6,036	60,377	217,548		2,659,450	134
217	110,818					13,496	593	12,903	27,829		206,558	135
43	17,884	1	375			4,034	837	3,197	5,886		44,994	136
2,394	1,134,215	4,432	3,189,724	$8,499	40	443,170	143,771	299,399	859,755		7,313,712	137
107	45,232	63	29,145			17,914	2,201	15,713	51,879	[2]409,200	150,680	138
21	4,556					256	245	11	580	8,882	10,055	139
568	308,142	4,368	3,159,975	8,499	40	312,198	105,607	206,591	510,092	5,271,609	5,579,869	140
65	21,383					9,572	3,087	6,485	8,627	[3]9,798	56,561	141
76	22,349					12,314	2,271	10,043	2,639	24,367	46,911	142
430	159,793					20,841	6,363	14,478	135,560		453,030	143
1	1,716					640	600	40	1,250	2,520	10,950	144
12	5,394					51		51	1,152		15,605	145
817	435,372					43,856	11,430	32,426	107,435		758,203	146
145	72,179					5,523	1,967	3,556	18,078		118,094	147
149	58,099	1	294			20,005	10,000	10,005	22,403		114,974	148
4,140	2,472,288	102	53,117	1,853	7	273,794	44,325	229,406	762,335		4,671,855	149
203	99,740					10,192	112	10,090	133,609		339,349	150
130	72,730					7,837	460	7,377	18,321		165,489	151
342	222,977					36,540	19,982	16,558	59,185		487,366	152
3,395	2,045,340					211,745	19,471	192,274	509,702		3,451,397	153
70	31,501	102	53,117	1,853	7	8,577	4,400	4,177	41,214		228,254	154
10,578	6,184,324	21,373	13,919,292	77,047	121	3,869,461	2,311,479	1,557,982	9,341,409		56,157,858	155
938	535,770					170,477		170,477	704,237	[4]1,577,006	2,134,396	156
150	87,401	1,295	988,404	7,500	14	106,414	48,127	58,287	92,448	964,718	1,653,192	157
4,817	2,896,064	9,070	5,848,828	11,725	9	173,501	2,842	170,659	4,688,419		18,217,207	158
313	152,143	16	24,464			44,715		44,715	88,634	208,563	459,621	159
8,494	2,075,167	10,962	7,057,596	57,382	96	3,004,384	2,254,864	749,520	3,061,194	[5]11,135,215	26,695,860	160
665	325,379					36,464	300	36,164	89,609		657,072	161
151	86,108					20,642	5,235	15,407	13,798		188,073	162
50	26,402			110	3	12,864	111	12,753	12,995		121,937	163
4,172	2,670,752	5,588	3,720,432	339,244	726	4,242,864	3,681,664	561,200	2,868,340		25,728,645	164
2,668	1,656,501	5,588	3,720,432	338,244	723	4,134,526	3,648,750	485,776	2,699,115	[6]15,137,650	23,989,227	165
785	481,561			1,000	3	50,380	23,941	26,439	103,794		905,857	166
						190		190			8,000	167
305	215,068					45,740	7,471	38,269	13,158		347,472	168
414	317,622					12,028	1,502	10,526	52,273		478,089	169
5,700	3,111,848	9,651	5,645,519	172,514	441	2,118,436	1,398,827	719,609	2,859,018		20,284,636	170
235	98,520	4	1,270			18,951	11,515	7,436	2,405	31,334	104,677	171
78	40,462	12	25,707	77	3	11,704	6,264	5,440	11,123	121,401	151,862	172
664	362,857	5,837	3,564,301	42,031	110	250,078	118,135	131,943	308,821	3,890,154	6,374,642	173
147	56,675	1	600	500	50	3,378	2,538	840	26,652	[8]46,309	105,379	174
2,846	1,658,482	3,767	2,053,441	105,877	198	1,768,458	1,235,753	532,705	2,189,461	[9]364,764	12,555,560	175
1,434	752,178			14,766	61	51,506	17,952	33,554	262,222		1,697,139	176
				950	7	591		591	600		2,154	177
56	31,988					621	92	529	7,664		66,990	178
179	101,624					8,256	5,350	2,906	32,104		167,708	179
62	26,052			8,184	12	4,898	1,228	3,670	22,568		94,525	180
2,520	2,825,852	8,019	8,996,298	64,656	85	893,258	231,774	661,484	5,007,102		28,255,085	181
257	230,364	1,330	1,285,679	1,000	13	118,693	41,153	77,540	283,900	1,760,823	2,443,447	182
1,192	1,410,431	5,196	5,929,342	40,975	28	456,108	85,409	370,699	3,649,127		20,763,353	183
837	976,005	1,441	1,712,047	19,161	26	310,145	102,168	207,977	1,069,300		4,688,536	184
91	70,078					829		829	8,035		104,725	185
24	25,811	15	18,150			830		830	5,920		115,000	186
57	52,117					3,882	3,044	838	5,810		85,172	187
21	26,488					278		278	2,563		77,050	188
41	31,855	37	11,080	3,500	18	2,493	300	2,193	32,397		187,822	189
178	95,935					2,790	823	1,967	11,173		148,391	190
178	95,935					2,790	823	1,967	11,173		148,391	191
410	437,291	722	768,274	7,944	13	177,355	50,003	127,352	623,457		3,518,430	192
372	408,573	703	753,764	7,944	13	172,206	49,652	122,554	599,928		3,409,348	193
2	1,583					351	351		250		6,115	194
36	27,135	19	14,510			4,798		4,798	23,279		102,967	195

[8] Includes 2 operators for cement.

[9] Includes 124,537 short tons of lead ore and 240,057 short tons of zinc ore.

[10] Includes operators as follows: Cement, 1; infusorial earth, tripoli, and pumice, 2; mineral pigments, crude, 2; nickel and cobalt, 1; petroleum, 2 (10 wells); sulphur and pyrite, 2.

[11] Includes operators as follows: Corundum and emery, 1; flint, 1; graphite, 1 (8 mines); grindstones and pulpstones (operator reported under sandstones and quartzites); gypsum, 2; iron ore, 3; manganese ore, 1; marble, 1.

[12] Includes operators as follows: Infusorial earth, tripoli, and pumice, 1 (2 quarries); limestones and dolomites, 33; sandstones and quartzites, 1.

[13] Includes operators as follows: Borax, 1; copper ore, 1; gypsum, 1; limestones and dolomites, 1; precious stones, 8 (1 mine); siliceous crystalline rocks, 1; sulphur and pyrite, 1.

TABLE 3.—DETAILED SUMMARY, STATES AND

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.					
						Total.		Men 16 years and over.		Boys under 16 years.	
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
196	New Hampshire	56	62	92	$68,971	1,253	$806,494	1,245	$804,171	8	$2,323
197	Siliceous crystalline rocks	51	49	87	65,648	1,219	791,196	1,211	788,873	8	2,323
198	All other minerals[1]	5	13	5	3,323	34	15,298	34	15,298		
199	New Jersey	132	151	420	357,000	5,645	2,658,727	5,626	2,654,651	19	4,076
200	Clay	34	34	35	36,041	702	293,232	697	292,048	5	1,184
201	Iron ore	15	9	138	101,870	1,660	773,286	1,655	772,212	5	1,074
202	Limestones and dolomites	27	25	15	11,301	187	80,654	187	80,654		
203	Marl	10	10			6	2,860	6	2,860		
204	Sandstones and quartzites	22	22	28	17,847	418	282,490	416	282,090	2	400
205	Siliceous crystalline rocks	19	46	92	64,508	947	433,166	941	431,948	6	1,218
206	All other minerals[3]	5	5	112	135,150	1,725	843,049	1,724	842,849	1	200
207	New Mexico	161	207	175	209,969	2,275	1,646,833	2,252	1,639,251	23	7,582
208	Coal, bituminous	30	25	68	85,569	1,439	1,027,460	1,419	1,021,028	20	6,432
209	Copper ore	17	17	24	32,120	164	128,483	164	128,483		
210	Gold and silver	91	91	75	80,880	519	409,779	516	408,629	3	1,150
211	Precious stones	8	60	3	5,100	36	22,087	36	22,087		
212	Sandstones and quartzites	7	7			8	6,515	8	6,515		
213	All other minerals[4]	8	7	5	6,300	109	52,509	109	52,509		
214	New York	9,768	2,921	791	788,382	9,560	5,099,753	9,490	5,081,972	70	17,781
215	Buhrstones and millstones	22	22	5	3,740	59	28,021	59	28,021		
216	Cement	21	20	141	160,282	2,459	1,203,313	2,425	1,194,175	34	9,138
217	Clay	8	7	5	2,575	14	6,396	14	6,396		
218	Corundum and emery	3	3	5	2,349	9	4,446	9	4,446		
219	Garnet	3	3	7	6,050	83	47,093	83	47,093		
220	Graphite	3	3	7	6,627	71	35,583	71	35,583		
221	Gypsum	17	15	22	32,600	214	100,996	214	100,996		
222	Iron ore	16	13	62	65,231	965	132,039	963	131,589	2	450
223	Limestones and dolomites	181	178	174	166,459	2,422	1,214,742	2,410	1,212,053	12	2,689
224	Marble	11	13	34	40,634	169	332,096	169	332,096		
225	Mineral pigments, crude	5	5			4	2,257	4	2,257		
226	Natural gas	612	108	76	63,015	121	84,476	121	84,476		
227	Petroleum	8,443	2,123	69	92,116	408	296,713	408	296,713		
228	Sandstones and quartzites	377	364	86	67,463	1,284	785,694	1,276	783,574	8	2,120
229	Siliceous crystalline rocks	22	22	47	42,942	655	357,329	643	354,402	12	2,927
230	Slate	11	11	17	14,645	126	69,561	124	69,104	2	457
231	Talc and soapstone	4	4	29	19,654	163	83,680	163	83,680		
232	All other minerals[9]	7	7	5	2,000	34	15,328	34	15,328		
233	North Carolina	126	137	120	94,221	1,556	517,765	1,537	514,849	19	2,916
234	Barytes	5	5	13	5,401	34	9,914	34	9,914		
235	Gold and silver	15	15	21	18,267	203	68,822	201	68,512	2	310
236	Limestones and dolomites	4	4	1	600	17	4,727	17	4,727		
237	Mica	28	26	4	1,411	56	15,160	56	15,160		
238	Monazite	23	22	3	2,100	88	25,318	88	25,318		
239	Siliceous crystalline rocks	30	27	31	23,578	615	222,868	607	221,568	8	1,300
240	Talc and soapstone	6	6	12	7,710	62	21,416	62	21,416		
241	All other minerals[12]	15	32	35	25,157	487	151,540	478	150,234	9	1,306
242	North Dakota	48	48	52	43,980	298	196,634	297	196,331	1	303
243	All minerals[13]	48	48	52	43,980	298	196,634	297	196,331	1	303
244	Ohio	44,931	11,268	2,560	2,551,083	37,173	23,222,680	36,809	23,119,743	364	102,937
245	Cement	7	7	19	57,838	375	227,548	375	227,548		
246	Clay	31	31	13	8,580	120	58,818	120	58,818		
247	Coal, bituminous	648	513	1,314	1,222,966	25,963	16,693,464	25,627	16,596,705	336	96,759
248	Grindstones and pulpstones[14]	7	7	22	10,792	139	64,288	137	63,751	2	537
249	Iron ore	12	9	5	2,037	111	38,901	111	38,901		
250	Limestones and dolomites	259	249	265	155,451	3,065	1,454,528	3,057	1,452,727	8	1,801
251	Natural gas	1,352	417	241	221,837	699	441,581	699	441,581		
252	Petroleum	42,483	10,002	450	629,369	4,017	2,915,787	4,017	2,915,787		
253	Sandstones and quartzites[15]	115	21	200	218,590	2,363	1,171,674	2,345	1,167,834	18	3,840
254	Silica sand	10	7	18	13,908	155	69,675	155	69,675		
255	Sulphur and pyrite	6	3			1	400	1	400		
256	All other minerals[16]	1	2	13	9,635	165	86,213	165	86,213		
257	Oklahoma	21	17	18	12,221	128	64,545	127	64,440	1	105
258	Limestones and dolomites	12	12	4	3,033	46	22,277	45	22,172	1	105
259	All other minerals[17]	9	5	14	9,188	82	42,268	82	42,268		

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[1] Includes operators as follows: Infusorial earth, tripoli, and pumice, 1; mica, 2; oilstones, whetstones, and scythestones (2 mines; operator reported in Arkansas); precious stones, 10 (no mines).

[2] Long tons.

[3] Includes operators as follows: Cement, 2; lead and zinc ore, 1; slate, 1; talc and soapstone, 1.

[4] Includes operators as follows: Graphite, 1; iron ore, 1 (2 mines); lead and zinc ore, 1; marble, 2; mica, 1; phosphate rock, 1.

[5] Stones.

[6] Barrels.

[7] Includes 50 tons crude.

[8] Barrels of 42 gallons.

[9] Includes operators as follows: Crystalline quartz, 1; feldspar, 1; flint, 2; infusorial earth, tripoli, and pumice, 1; lead and zinc ore, 1; sulphur and pyrite, 1.

TERRITORIES, BY MINERALS: 1902—Continued.

WAGE-EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.		
Above ground.		Below ground.		Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		Quantity (short tons).	Value.	
Average number.	Wages.	Average number.	Wages.									
1,252	$716,169	1	$325			$26,993	$2,372	$24,621	$134,128		$1,176,312	196
1,219	701,196					26,719	2,372	24,347	132,122		1,147,097	197
33	14,973	1	325			274		274	2,006		29,215	198
4,436	2,075,139	1,209	583,588	$10,770	113	303,669	110,163	193,506	2,235,964		6,605,402	199
702	293,232					19,403	6,939	12,464	67,476	494,800	612,722	200
636	277,522	1,024	495,764	10,770	113	30,114	7,915	22,199	429,231	[2]141,879	1,228,664	201
187	80,654					7,833	3,869	3,964	23,044		168,650	202
6	2,860					60		60	235	8,172	4,865	203
418	232,480					18,352	13,647	4,705	36,090		406,725	204
947	433,166					53,135	13,620	39,515	164,562		946,171	205
1,540	755,225	185	87,824			174,772	64,178	110,594	1,515,326		3,215,302	206
594	432,223	1,681	1,214,610	48,581	173	140,055	64,438	75,617	197,949		2,686,473	207
285	198,173	1,154	829,287	5,770	81	63,990	26,668	37,322	156,513	1,018,763	1,500,230	208
29	29,842	135	98,641	10,296	31	26,858	12,123	14,735	49,408		271,270	209
111	131,252	378	278,527	82,345	61	34,110	13,127	20,983	256,816		677,168	210
22	13,932	14	8,166			1,900		1,900	2,490		51,600	211
8	6,516					586		586	370		12,291	212
109	52,509					12,661	12,520	141	32,362		173,914	213
8,367	4,557,510	1,193	642,248	355,113	284	1,276,232	369,281	906,951	8,002,554		13,350,421	214
59	28,021					849	123	726	1,499	[3]5,156	39,570	215
2,063	1,022,946	376	180,367	4,450	4	310,772	11,644	299,128	1,374,640	[6]4,734,147	3,656,589	216
14	6,896					1,087	400	687	1,096	8,909	14,585	217
9	1,146					2,171	1,091	1,080	2,575	2,886	44,625	218
83	47,093					3,200		3,200	8,200	2,760	97,600	219
36	19,053	35	16,530			1,124	60	1,064	19,543	[5]1,376	77,437	220
141	67,108	73	33,566			14,081	7,501	6,580	31,175	95,318	259,170	221
352	162,258	613	259,761			199,587	12,385	187,202	293,950	[2]555,371	1,382,967	222
2,422	1,214,742					142,206	28,662	113,544	451,876		2,509,536	223
469	332,096					31,283	6,025	25,258	100,705		577,296	224
4	2,257					90	25	65	735	1,261	4,251	225
121	84,476			77,904	97	127,530	32,439	95,091	39,920		346,471	226
408	296,713			272,759	183	259,740	194,717	65,023	440,004	[6]1,119,739	1,530,852	227
1,284	785,694					104,493	31,309	73,184	108,130		1,406,899	228
655	357,829					29,157	10,180	18,977	94,299		651,014	229
126	69,561					8,429	3,492	4,937	16,225		128,718	230
77	46,278	86	37,402			38,786	28,226	10,560	15,253	71,100	615,350	231
24	10,758	10	4,575			1,647	1,002	645	2,750		33,719	232
1,138	387,744	419	130,023	9,000	40	76,842	19,971	56,871	118,782		927,376	233
2	450	32	9,464	1,000	10	5,886	5,680	206	2,740	11,679	44,130	234
81	28,514	122	38,308			10,238	415	9,823	26,490		71,287	235
17	4,727			8,000	30	763	488	275	3,898		23,153	236
38	11,728	12	3,432			2,952	2,592	360	3,121	(10)	71,148	237
86	25,318					2,083	1,739	344	256	[11]802,000	64,160	238
615	222,668					16,463	5,585	10,878	42,884		338,750	239
54	18,716	8	2,700			27,981	720	27,261	12,447	6,238	88,962	240
243	75,423	244	76,117			10,476	2,752	7,724	26,856		225,786	241
45	28,630	253	167,904	2,795	9	23,012	1,407	21,605	88,867		334,967	242
45	28,630	253	167,904	2,795	9	23,012	1,407	21,605	88,867		334,967	243
13,765	8,060,591	23,400	15,162,089	2,701,557	2,619	7,711,026	4,192,221	3,518,805	10,126,452		57,186,922	244
366	219,962	9	7,586			71,829	1,677	70,152	231,322	[6]597,068	714,551	245
65	28,133	55	30,685	1,414	1	7,072	3,476	3,596	12,316	142,440	101,305	246
2,792	1,644,456	23,171	15,019,008	46,818	290	1,619,451	854,604	764,847	2,092,788	23,519,894	25,953,789	247
139	61,288					9,992	1,898	8,094	19,777	19,957	590,412	248
24	10,661	87	28,240			1,556	1,503	53	345	22,657	41,976	249
3,065	1,154,328			7,278	16	139,648	41,223	98,425	560,462		3,204,998	250
699	441,581			433,026	115	491,223	198,671	292,552	1,189,201		2,355,458	251
4,017	2,915,787			2,212,923	1,892	4,896,861	3,046,994	1,849,867	5,604,782	[6]21,011,231	20,757,359	252
2,363	1,171,671					437,827	16,595	421,232	626,721		2,078,754	253
155	69,675			100	2	7,566	3,139	4,427	13,768	132,921	152,274	254
1	103									28,068	25,129	255
79	39,613	86	46,570			28,011	22,441	5,570	35,300		240,917	256
128	64,545					15,830	11,667	4,163	31,934		186,706	257
46	22,277					840	200	640	6,737		50,541	258
82	42,268					14,990	11,467	3,523	25,197		136,165	259

[10] Cut or sheet mica, 303,816 pounds; scrap or waste, 544 short tons.

[11] Pounds.

[12] Includes operators as follows: Buhrstones and millstones (operator reported under siliceous crystalline rocks); clay, 3; coal, bituminous, 1; copper ore, 2; garnet, 1; graphite, 2; iron ore, 3; precious stones, 18 (1 mine); sandstones and quartzites, 2.

[13] Includes operators as follows: Cement, 1; coal, bituminous, 47.

[14] Includes grindstones and pulpstones, valued at $399,725, for which all operating expenses are reported under sandstones and quartzites.

[15] Includes operating expenses of grindstones and pulpstones, valued at $399,725, produced in sandstone quarries.

[16] Includes operators as follows: Gypsum (2 quarries; operator reported in Michigan); oilstones, whetstones, and scythestones, 1; phosphate rock, 1.

[17] Includes operators as follows: Gypsum, 3 (5 quarries); petroleum, 1 (3 wells); sandstones and quartzites, 1.

TABLE 3.—DETAILED SUMMARY, STATES AND

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE EARNERS.					
				Number.	Salaries.	Total.		Men 16 years and over.		Boys under 16 years.	
						Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
260	Oregon	294	293	153	$189,013	1,176	$1,033,075	1,167	$1,030,471	9	$2,604
261	Coal, bituminous	9	9	32	27,660	211	144,801	204	142,617	7	2,184
262	Gold and silver	262	262	110	146,473	865	816,711	863	816,291	2	420
263	Limestones and dolomites	7	6	1	1,200	19	10,102	19	10,102	...	...
264	Siliceous crystalline rocks	10	10	3	2,500	35	25,454	35	25,454	...	...
265	All other minerals[1]	6	6	7	11,180	46	36,007	46	36,007	...	...
266	Pennsylvania	18,672	12,266	9,438	8,692,910	190,935	114,122,437	184,512	112,658,224	6,423	1,464,213
267	Buhrstones and millstones	3	3	...	...	1	616	1	616	...	...
268	Cement	17	14	207	250,252	5,376	2,411,652	5,331	2,402,459	45	9,193
269	Clay	19	19	22	28,473	312	130,753	311	130,453	1	300
270	Coal, anthracite	331	119	3,014	2,007,293	69,691	38,716,113	65,127	37,753,598	4,564	962,515
271	Coal, bituminous	1,028	514	3,930	4,142,497	92,095	59,818,902	90,483	59,399,959	1,612	418,943
272	Feldspar	12	12	9	8,712	125	50,876	123	50,456	2	420
273	Flint	4	3	1	1,500	27	11,713	27	11,713	...	...
274	Iron ore	47	42	91	74,788	1,140	436,207	1,118	433,295	22	2,912
275	Limestones and dolomites	907	896	257	228,826	6,934	2,881,295	6,901	2,872,285	33	9,010
276	Marble	3	3	8	7,465	169	95,623	166	95,123	3	500
277	Mineral pigments, crude	12	12	40	41,002	148	67,006	148	67,006	...	...
278	Natural gas	5,406	393	718	769,042	2,115	1,309,205	2,115	1,309,205	...	...
279	Petroleum	10,444	9,808	550	686,098	5,610	4,072,287	5,610	4,072,287	...	...
280	Sandstones and quartzites	283	258	252	177,786	2,834	1,779,993	2,809	1,774,117	25	5,876
281	Silica sand	14	11	15	11,890	141	64,015	141	64,015	...	...
282	Siliceous crystalline rocks	44	43	58	60,877	703	341,720	702	341,480	1	240
283	Slate	91	84	259	190,555	3,426	1,876,175	3,311	1,854,871	115	21,304
284	All other minerals[7]	7	62	7	5,854	58	26,296	58	26,296	...	...
285	Rhode Island	22	22	56	56,150	667	435,224	667	435,224	...	...
286	Siliceous crystalline rocks	19	19	54	55,310	638	421,608	638	421,608	...	...
287	All other minerals[8]	3	3	2	840	29	13,616	29	13,616	...	...
288	South Carolina	38	42	148	126,992	2,691	891,737	2,661	887,419	30	4,318
289	Clay	8	8	14	11,300	198	45,448	190	44,288	8	1,160
290	Phosphate rock	10	10	80	65,401	1,498	435,553	1,498	435,553	...	...
291	Siliceous crystalline rocks	15	14	41	32,841	815	351,046	793	347,888	22	3,158
292	All other minerals[9]	5	10	13	17,450	180	59,690	180	59,690	...	...
293	South Dakota	77	77	167	242,461	3,131	3,344,776	3,130	3,344,626	1	150
294	Gold and silver	40	40	148	222,590	2,911	3,217,456	2,911	3,217,456	...	...
295	Limestones and dolomites	10	10	1	1,278	55	13,714	55	13,714	...	...
296	Mica	5	3	9	9,580	22	18,288	22	18,288	...	...
297	Natural gas	6	3	...	...	...	...	...	...	...	...
298	Sandstones and quartzites	12	12	4	2,833	94	69,509	93	69,359	1	150
299	All other minerals[11]	6	9	5	6,180	46	25,809	46	25,809	...	...
300	Tennessee	241	203	773	664,379	10,890	4,864,241	10,564	4,805,250	326	58,991
301	Barytes	6	6	1	1,000	26	7,525	24	7,225	2	300
302	Clay	9	9	4	1,900	46	13,140	46	13,140	...	...
303	Coal, bituminous	84	73	418	281,929	6,220	3,213,532	6,046	3,181,690	174	31,842
304	Iron ore	22	13	106	71,855	1,299	512,702	1,205	495,293	94	17,409
305	Limestones and dolomites	51	44	37	27,826	698	222,475	681	219,918	17	2,557
306	Marble	11	10	38	37,410	607	218,764	604	218,404	3	360
307	Phosphate rock	40	37	115	82,125	1,597	493,809	1,577	490,352	20	3,457
308	Sandstones and quartzites	8	4	3	1,140	10	4,086	10	4,086	...	...
309	All other minerals[13]	15	8	51	59,184	387	178,208	371	175,142	16	3,066
310	Texas	1,067	308	1,210	661,805	3,853	2,261,639	3,814	2,253,164	39	8,475
311	Clay	3	3	...	...	...	...	...	...	...	...
312	Coal, bituminous	26	24	91	90,096	1,979	991,391	1,953	985,565	26	5,826
313	Limestones and dolomites	35	34	30	21,386	275	124,272	271	123,118	4	1,154
314	Natural gas	11	6	1	2,000	...	...	...	...	...	...
315	Petroleum	955	211	999	441,129	723	699,209	723	699,209	...	...
316	Quicksilver	5	3	19	19,876	233	87,414	227	86,434	6	980
317	Sandstones and quartzites	13	13	11	8,689	191	100,399	191	100,399	...	...
318	Siliceous crystalline rocks	8	8	9	8,400	56	11,184	55	11,034	1	150
319	All other minerals[14]	8	7	51	70,229	396	217,770	394	217,405	2	365
320	Utah	178	170	413	587,005	5,712	5,090,122	5,691	5,081,068	21	9,054
321	Coal, bituminous	39	36	67	80,065	1,576	1,254,090	1,562	1,249,096	14	4,994
322	Copper ore	14	13	51	71,155	487	499,612	487	499,612	...	...
323	Gold and silver	83	83	261	391,317	3,349	3,176,599	3,345	3,174,289	4	2,310
324	Limestones and dolomites	16	15	7	2,295	103	77,296	103	77,296	...	...
325	Sandstones and quartzites	10	6	6	6,720	65	50,225	64	50,075	1	150
326	Siliceous crystalline rocks	5	5	...	...	1	330	1	330	...	...
327	All other minerals[15]	12	12	21	35,453	131	90,970	129	90,370	2	600

[1] Includes operators as follows: Borax, 1; copper ore, 2; gypsum, 1; nickel and cobalt, 1; sandstones and quartzites, 1.

[2] Stones.

[3] Barrels.

[4] Long tons.

[5] Includes 4,238 tons crude.

[6] Barrels of 42 gallons.

[7] Includes operators as follows: Crystalline quartz, 1; garnet, 1; graphite, 2; phosphate rock, 1; precious stones, [illegible]; talc and soapstone, 2.

[8] Includes operators as follows: Graphite, 1; limestones and dolomites, 2.

TERRITORIES, BY MINERALS: 1902—Continued.

WAGE-EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.		
Above ground		Below ground										
Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest and other sundries.		Quantity (short tons).	Value.	
562	$473,043	605	$560,032	$19,522	57	$143,768	$60,429	$83,249	$408,112	......	$2,067,380	260
42	28,103	160	116,668			25,757	1,647	24,110	86,355	65,648	160,075	261
436	387,777	419	428,964	19,197	55	114,402	58,292	56,110	299,705		1,891,853	262
19	10,102					120		120	1,220		20,133	263
35	25,454					977	600	377	1,496		78,429	264
30	21,607	16	14,400	325	2	2,512		2,512	16,330		16,890	265
68,390	31,582,467	122,545	79,580,970	5,598,074	5,162	25,218,856	10,735,258	12,482,598	33,111,963	......	246,871,417	266
1	616					122	63	58	61	2,199	1,978	267
6,376	2,411,652					711,782	13,448	698,334	4,048,808	9,360,802	10,223,267	268
248	104,406	64	26,547	300	1	13,825	6,445	7,380	42,309	161,546	288,811	269
27,964	12,133,983	41,727	26,582,150	406,421	1,751	9,097,229	4,159,061	4,918,188	12,740,780	36,940,710	76,173,586	270
11,660	6,996,388	80,135	52,852,511	474,679	985	6,178,975	2,714,816	3,464,159	8,221,175	98,574,367	106,032,460	271
125	50,876					9,074	4,818	4,256	32,125	15,121	115,699	272
27	11,713					3,137	2,074	1,063	4,425	9,785	42,721	273
873	329,450	265	105,757	1,228	4	61,376	26,343	35,033	166,122	22,932	1,225,178	274
6,934	2,881,295					260,428	168,747	91,681	972,665		5,458,138	275
169	95,623					4,274	300	3,974	28,450		160,123	276
107	49,553	41	17,453			21,259	12,651	8,608	22,816	20,907	246,346	277
2,115	1,308,265			1,745,500	988	2,899,633	1,223,278	1,676,355	2,667,228		11,352,183	278
5,610	4,072,287			2,969,066	1,696	3,275,131	1,916,987	1,358,144	3,356,605	12,063,880	15,266,003	279
2,964	1,779,993					108,608	51,792	56,816	208,883		2,810,108	280
141	64,015					8,255	2,475	5,780	16,572	298,292	295,675	281
703	341,720					41,056	25,025	16,031	128,968		661,062	282
3,426	1,979,175					312,186	207,130	105,056	417,778		3,547,322	283
47	21,517	11	4,769	900	2	2,497	815	1,682	12,575		69,797	284
667	435,224					27,938	15,143	10,795	85,127		774,611	285
638	421,608					22,898	13,643	9,255	71,908		734,625	286
29	13,616					5,040	1,500	1,540	13,219		39,988	287
2,613	863,637	81	28,100			109,890	48,691	61,199	342,579		1,831,134	288
198	45,448					3,185		3,185	11,612	29,136	107,325	289
1,498	435,563					65,157	38,333	26,824	162,896	327,557	950,208	290
815	351,066					34,047	7,488	26,559	131,771		598,818	291
102	31,560	81	28,100			7,501	2,870	4,631	36,100		177,773	292
1,069	1,066,146	2,062	2,308,650	8,349	12	264,452	8,736	255,716	1,992,575		6,769,104	293
856	911,724	2,058	2,305,782			240,112	6,406	233,706	1,596,617		6,464,248	294
55	43,714					366	26	340	10,485		86,665	295
19	14,900	2	2,380			7,406		7,406	4,579	[10]	18,450	296
				7,943	5						10,290	297
91	69,509					4,669	2,259	2,410	9,708		110,789	298
45	25,299	1	510	406	7	11,899	45	11,854	31,221		78,722	299
4,722	1,671,384	6,168	3,192,857	174,406	387	720,483	114,367	606,116	840,485		9,538,782	300
26	7,725					475	455	20	510	3,255	14,647	301
16	13,140					3,745	60	3,685	767	14,650	27,171	302
834	400,088	5,386	2,813,444	14,004	71	432,029	245,001	187,028	390,561	1,392,968	5,099,721	303
845	276,937	154	238,766			111,854	93,672	18,182	141,540	874,542	1,123,527	304
608	222,475					11,462	5,749	5,713	101,195		182,023	305
607	218,764					11,268	6,100	5,168	18,726		518,256	306
1,535	172,509	62	21,300	157,102	306	81,882	53,754	28,128	93,715	432,603	1,308,872	307
10	4,086					329		329	660		7,670	308
121	55,860	566	122,348	3,000	10	67,439	9,576	57,863	90,782		651,885	309
1,823	1,235,452	2,030	1,026,237	1,387,796	1,068	923,769	206,130	628,639	1,051,457		6,981,532	310
						150		150		310	455	311
237	87,307	1,742	904,084	38	2	102,237	17,459	84,778	99,127	961,912	1,477,245	312
275	124,272					8,458	2,570	5,888	34,222		228,662	313
				18,812	17	2,642	2,062	580	125		14,953	314
725	689,209			1,363,443	1,061	713,176	561,150	152,026	674,937	18,515,017	4,171,731	315
47	24,981	186	62,583	255	1	6,305		6,305	73,373	[13]	251,360	316
191	100,890					7,644	5,415	2,229	21,261		165,565	317
56	41,184					2,304	1,295	1,009	5,095		60,003	318
294	158,200	102	59,570	5,248	14	80,883	5,169	75,714	142,317		605,568	319
1,436	1,269,954	1,276	3,839,168	37,054	126	761,557	41,098	720,459	1,885,458		12,378,350	320
261	190,228	1,315	1,073,862	340	2	91,123	643	90,480	195,114	1,574,521	1,707,454	321
41	40,934	146	398,678			71,448	12,166	59,282	166,226		1,459,192	322
848	821,769	2,500	2,365,030	28,493	77	570,250	23,215	547,035	1,312,176		8,500,904	323
103	77,296			250	5	4,457	1,080	3,377	55,046		186,668	324
65	50,225			500	5	4,460	840	3,620	5,070		105,011	325
1	390					63		63	130		1,479	326
117	79,372	14	11,508	7,471	15	16,756	1,126	15,630	80,895		327,647	327

[7] Includes operators as follows: Gold and silver, 3; limestones and dolomites, 1; manganese ore, 1; precious stones, 5 (no mines).

[10] 6,000 pounds cut or sheet mica, 205 short tons rough as mined.

[11] Includes operators as follows: Cement, 1; graphite, 2; gypsum, 2; lithium ore, 1; precious stones, 5 (no mines).

[12] Includes operators as follows: Copper ore, 2; fluorspar, 1; gold and silver, 2; mineral pigments, crude, 1; natural gas, 1 (2 wells); petroleum, 1 (7 wells).

[13] Quicksilver, 5,319 flasks (76½ pounds each); cinnabar, 1,300 short tons.

[14] Includes operators as follows: Asphaltum and bituminous rock, 1; cement, 2; gold and silver, 1; gypsum, 2; iron ore, 1 (2 mines).

[15] Includes operators as follows: Asphaltum and bituminous rock, 2; cement, 1; clay, 1; gypsum, 1; iron ore, 4; marble, 2; sulphur and pyrite, 1.

TABLE 3.—DETAILED SUMMARY, STATES AND

	STATE OR TERRITORY AND MINERALS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.					
						Total.		Men 16 years and over.		Boys under 16 years.	
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
328	Vermont	192	160	433	$376,077	5,398	$3,114,399	5,334	$3,098,501	64	$15,898
329	Limestones and dolomites	14	13	12	7,953	156	65,093	156	65,093		
330	Marble	22	16	195	184,877	2,074	1,206,208	2,068	1,205,308	6	900
331	Siliceous crystalline rocks	74	68	128	104,655	1,505	958,950	1,485	953,508	20	5,442
332	Slate	76	58	97	78,442	1,639	874,263	1,601	864,707	38	9,556
333	All other minerals[1]	6	5	1	150	24	9,895	24	9,895		
334	Virginia	192	140	700	546,204	8,993	3,458,450	8,605	3,391,922	388	66,528
335	Barytes	4	3	10	8,088	37	13,047	37	13,047		
336	Buhrstones and millstones	3	3	2	942	17	6,725	17	6,725		
337	Cement	3	3	43	11,675	178	83,423	172	82,126	6	1,297
338	Coal, bituminous	26	22	179	155,930	3,004	1,407,867	2,884	1,385,948	120	21,919
339	Gold and silver	5	5	4	1,815	[illegible]	11,584	43	11,584		
340	Iron ore	62	25	257	174,034	2,686	888,958	2,493	856,737	193	32,221
341	Limestones and dolomites	37	28	63	35,450	890	290,979	854	284,643	36	6,336
342	Manganese ore	6	6	10	4,241	113	33,603	109	33,463	4	140
343	Siliceous crystalline rocks	17	17	21	12,904	469	190,322	464	189,272	5	1,050
344	Slate	4	4	15	11,490	247	97,645	240	96,997	7	648
345	Sulphur and pyrite	6	4	32	29,970	655	222,986	642	220,969	13	2,017
346	All other minerals[5]	19	20	64	66,656	654	211,011	650	210,411	4	600
347	Washington	90	84	258	328,289	4,567	3,735,484	4,528	3,722,326	39	13,158
348	Coal, bituminous	27	22	160	221,915	3,931	3,220,263	3,893	3,207,205	38	13,058
349	Gold and silver	31	31	34	36,065	229	232,058	229	232,058		
350	Limestones and dolomites	12	12	22	35,701	147	87,850	147	87,850		
351	Marble	5	5	12	10,400	63	46,099	62	45,999	1	100
352	Sandstones and quartzites	3	3	4	4,100	32	23,237	32	23,237		
353	Siliceous crystalline rocks	9	8	20	11,948	137	95,949	137	95,949		
354	All other minerals[6]	3	3	6	8,160	28	30,028	28	30,028		
355	West Virginia	14,874	5,192	2,614	2,434,150	30,002	17,469,826	29,132	17,252,962	870	216,864
356	Clay	4	4	1	720	41	25,022	41	25,022		
357	Coal, bituminous	522	405	1,987	1,766,448	23,914	13,524,429	23,065	13,312,617	849	211,812
358	Limestones and dolomites	174	167	31	27,259	1,068	426,401	1,059	424,364	9	2,037
359	Natural gas	949	63	221	225,501	634	410,845	634	410,845		
360	Petroleum	13,109	4,446	328	390,207	3,800	2,773,312	3,800	2,773,312		
361	Sandstones and quartzites	110	100	38	18,965	453	272,123	442	269,204	11	2,919
362	All other minerals[8]	6	6	8	5,050	92	37,694	91	37,598	1	96
363	Wisconsin	411	392	275	226,755	3,583	1,987,565	3,570	1,983,964	13	3,601
364	Clay	3	3	2	3,600	36	16,050	34	15,450	2	600
365	Iron ore	16	10	83	85,262	1,361	837,661	1,354	835,394	7	2,267
366	Lead and zinc ore	90	90	50	20,202	417	192,209	416	191,943	1	266
367	Limestones and dolomites	216	207	82	58,353	1,062	539,169	1,061	538,959	1	210
368	Sandstones and quartzites	62	62	13	9,129	199	109,066	198	108,958	1	108
369	Siliceous crystalline rocks	18	15	30	31,281	391	236,495	390	236,345	1	150
370	All other minerals[10]	6	5	15	18,928	117	56,915	117	56,915		
371	Wyoming	74	50	153	188,616	4,486	3,432,059	4,451	3,417,709	35	14,350
372	Coal, bituminous	36	22	125	159,153	4,197	3,207,545	4,162	3,193,195	35	14,350
373	Gold and silver	4	4	4	3,245	25	24,570	25	24,570		
374	Limestones and dolomites	3	3			7	5,040	7	5,040		
375	Sandstones and quartzites	12	12	3	2,038	74	58,897	74	58,897		
376	All other minerals[11]	19	9	21	24,180	183	135,407	183	135,407		

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[1] Includes operators as follows: Buhrstones and millstones, 1; clay, 2; iron ore, 1; mineral pigments, crude, 1; oilstones, whetstones, and scythestones (1 quarry, operator reported in Arkansas).

[2] Stones.

[3] Barrels.

[4] Long tons.

[5] Includes operators as follows: Asbestos, 1; copper ore, 1; flint, 1; gypsum, 2; infusorial earth, tripoli, and pumice, 2; lead and zinc ore (2 mines, operator reported under iron ore); marl, 1; mica, 2; mineral pigments, crude, 2; precious stones, 3 (no mines); rutile, 1; sandstones and quartzites, 2; talc and soapstone, 2.

TERRITORIES, BY MINERALS: 1902—Continued.

WAGE EARNERS—continued.				CONTRACT WORK.		MISCELLANEOUS EXPENSES.			Cost of supplies and materials.	PRODUCT.		
Above ground.		Below ground.										
Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.	Total.	Royalties and rent of mine and mining plant.	Rent of offices, taxes, insurance, interest, and other sundries.		Quantity (short tons).	Value.	
5,393	$5,112,563	5	$1,836	......	......	$582,734	$101,546	$281,188	$1,076,143	......	$5,904,705	328
156	65,083	......	......	......	......	5,810	2,750	3,060	116,301	......	225,704	329
2,074	1,206,208	......	......	......	......	226,103	27,663	198,440	523,075	......	2,628,164	330
1,505	958,950	......	......	......	......	70,673	17,059	53,614	272,888	......	1,570,123	331
1,639	874,263	......	......	......	......	79,700	53,794	25,906	162,410	......	1,464,918	332
19	8,060	5	1,836	......	......	468	300	168	1,469	......	15,497	333
5,289	1,846,134	3,704	1,612,316	$35,964	114	603,290	318,763	284,527	928,387	......	6,607,807	334
21	8,047	16	5,000	......	......	10,243	9,650	593	2,087	12,400	39,700	335
17	6,725	......	......	......	......	185	150	35	155	[7]964	11,155	336
163	79,428	15	1,000	......	......	31,497	......	31,497	91,100	[3]284,000	327,650	337
369	179,444	2,635	1,228,423	27,600	52	315,384	177,199	138,185	215,458	3,182,993	2,513,505	338
17	5,186	26	6,308	......	......	444	370	74	4,011	......	2,723	339
2,002	641,286	684	247,672	6,730	53	120,563	93,429	27,134	201,436	[4]973,301	1,652,790	340
890	200,979	......	......	......	......	24,898	6,659	18,239	126,956	......	545,113	341
73	22,418	10	11,495	......	......	600	421	179	8,091	[4]3,041	29,444	342
409	190,322	......	......	......	......	12,466	10,163	2,303	22,290	......	282,046	343
247	97,645	......	......	......	......	24,366	2,200	22,166	20,964	......	160,951	344
389	122,431	268	100,555	1,134	4	23,285	......	23,285	137,191	[4]127,642	501,642	345
632	202,228	22	8,783	500	5	39,369	18,522	20,847	97,758	......	520,700	346
1,208	844,457	3,359	2,891,027	28,600	30	225,161	56,558	168,603	615,907	......	5,393,659	347
773	582,485	3,168	2,087,778	200	3	150,213	10,780	139,433	473,254	2,481,214	1,572,295	348
51	53,484	178	178,574	29,100	27	23,651	11,876	8,775	55,608	......	338,251	349
147	87,850	......	......	......	......	8,498	902	7,596	28,425	......	213,811	350
63	46,092	......	......	......	......	9,350	......	9,350	22,349	......	61,176	351
32	23,257	......	......	......	......	350	......	350	4,315	......	30,725	352
137	95,949	......	......	......	......	2,644	......	2,644	21,264	......	147,278	353
5	5,333	23	24,675	......	......	455	......	455	10,592	......	30,025	354
10,138	6,080,421	19,864	11,889,405	5,194,279	1,783	7,468,306	3,874,780	3,593,566	8,519,767	......	48,378,414	355
14	6,156	27	18,866	......	......	1,618	......	1,618	10,421	57,506	43,266	356
4,077	2,153,890	19,837	11,870,539	23,092	79	2,087,528	1,215,940	871,588	2,327,377	24,570,826	24,748,658	357
1,068	425,401	......	......	......	......	8,144	376	7,768	78,146	......	616,866	358
684	410,845	......	......	991,510	298	822,639	507,868	314,771	1,495,069	......	5,390,181	359
3,800	2,773,312	......	......	4,176,547	1,406	4,523,499	2,132,243	2,391,256	4,504,008	[7]13,513,345	17,040,317	360
453	272,123	......	......	......	......	17,533	14,756	2,777	28,500	......	123,532	361
92	37,694	......	......	......	......	7,385	3,597	3,788	15,346	......	116,094	362
2,294	1,222,757	1,289	764,808	3,758	20	427,847	260,375	167,472	804,142	......	1,127,813	363
34	15,150	2	900	......	......	1,225	877	348	3,092	2,735	23,178	364
384	216,118	977	621,543	2,750	10	247,149	181,243	65,906	375,959	[4]783,996	1,800,864	365
122	56,924	295	135,285	1,008	10	54,534	52,876	1,658	56,774	[9]21,999	473,652	366
1,062	539,169	......	......	......	......	47,052	3,675	43,377	290,150	......	1,351,058	367
199	109,066	......	......	......	......	3,662	847	2,815	17,169	......	207,086	368
391	236,495	......	......	......	......	26,211	622	25,589	35,409	......	399,137	369
102	19,835	15	7,000	......	......	48,044	20,265	27,779	25,599	......	202,838	370
1,153	896,990	3,333	2,545,069	15,547	21	280,602	95,222	185,380	818,496	......	5,684,296	371
883	680,663	3,314	2,526,882	12,747	17	224,947	63,095	161,852	669,328	4,429,491	5,295,339	372
8	7,667	17	16,903	300	1	160	......	160	11,189	......	4,923	373
7	5,640	......	......	......	......	2	......	2	225	......	6,340	374
71	58,897	......	......	......	......	2,291	1,310	981	4,337	......	90,691	375
181	134,123	2	1,284	2,500	3	53,202	30,817	22,385	131,467	......	345,993	376

[6] Includes operators as follows: Clay, 1; copper ore, 1; molybdenum, 1.

[7] Barrels of 42 gallons.

[8] Includes operators as follows: Cement, 1; grindstones and pulpstones, 2; iron ore, 1; silica sand, 2.

[9] Includes 2,623 short tons of lead ore and 19,376 short tons of zinc ore.

[10] Includes operators as follows: Cement, 2; copper ore, 1; graphite, 1 (2 mines); mineral pigments, crude, 1.

[11] Includes operators as follows: Copper ore, 1; graphite (1 mine, operator reported in South Dakota); grindstones and pulpstones (operator reported under sandstones and quartzites); gypsum, 2 (3 quarries); iron ore, 1; petroleum, 2 (13 wells); precious stones, 3 (no mines).

REPORTS ON SEPARATE MINERALS

IRON ORE

IRON ORE.

By John Birkinbine.

The statistics which are given in this report refer solely to the iron ore mines located in the United States, excluding the insular possessions and Alaska; they show that in the year 1902, 35,567,410 long tons of iron ore were mined in the United States, 25 states and territories contributing to make this total. This includes 13,275 tons of special manganiferous iron ores obtained in Colorado. These ores were included because the labor and wages expended on them could not be segregated from those expended on the iron ores proper. The amount of true iron ore produced was 35,554,135 long tons.

The statistics included in this report do not show fully comparative data for the various census years because the inquiries at the different census periods were not identical. However, such as are shown will aid in a study of past and existing conditions.

Prior to 1880, the number of iron ore mines grew with the pig iron industry, individual blast furnaces depending largely upon mines which were adjacent to the plant or controlled by the same owners. Subsequently, as blast furnaces were enlarged requiring greater amounts of iron ore, it became necessary that several mines should be combined under the same management, or that existing mines should be exploited to a more liberal extent than before.

In Table 1 the statistics for each of the census years 1902, 1889, and 1880 are presented, but a résumé of the data, so far as it could be collated, for 1850, 1860, and 1870 is given, as follows: In 1850 the "number of establishments" was 197; the wage-earners were 2,195, receiving a total of $590,866 in wages; the cost of supplies and materials was $63,651, and the value of the product of the regular mining establishments to which these data refer was $1,217,803; but the amount of iron ore smelted was given as 1,579,309 long tons.

In 1860 the total amount of iron ore mined from 157 regular mining establishments was 908,300 short tons, or 810,982 long tons. These establishments gave employment to 3,177 persons, to whom $901,852 was paid in wages, and $249,099 was the cost of raw material. In addition, many of the large iron works of the country mined their own ore, the quantity thus raised amounting to 2,309,975 short tons, making the total quantity 3,218,275 short tons, or 2,873,460 long tons. While the short ton was not designated as the unit of measure in 1860 or 1870, it was reported in 1880 and presumably was used at prior censuses.

In 1870 there were 420 regular mining establishments, employing 15,022 wage-earners, who received as compensation $6,838,022. The cost of supplies and materials was $1,279,563. The product was 3,395,718 short tons, equivalent to 3,031,891 long tons, valued at $13,204,138. This production does not include the amount raised, between 800,000 and 900,000 tons, by some of the blast furnace operators, so that at a low estimate the production of 1870 reached a total of at least 3,831,891 long tons.

The inquiries for the census years 1902, 1889, and 1880 were more nearly identical than any of the others, and therefore a comparison of these gives results of greater immediate value. The statistics for these periods are summarized in the following table:

Table 1.—*Comparative summary: 1880 to 1902.*

	1902	1889	1880
Number of mines	525	592	(1)
Number of operators	332	(1)	[2]805
Salaried officials, clerks, etc.:			
Number	2,405	[3]520	1,253
Salaries	$2,113,230	$529,043	(4)
Wage-earners:			
Average number	38,851	[3]37,707	30,415
Wages	$21,581,792	$13,880,108	[4]$9,538,117
Contract work	$425,292	$1,578,010	(1)
Miscellaneous expenses	$6,257,714	$3,795,509	(1)
Cost of supplies and materials	$9,005,608	$4,998,988	$2,894,011
Product:			
Quantity, long tons	35,567,410	14,518,041	7,120,362
Value	$65,465,821	$33,351,978	$23,156,957

[1] Not reported.
[2] Establishments.
[3] Foremen included as wage-earners.
[4] Salaries included in wages.

The number of mines in 1902 shows an apparent decrease of 67 since 1889, which was caused in part by a difference in the methods followed at the two censuses. In the year 1889 all iron mines were included which were doing exploratory work. In the statistics for 1902, however, only the mines which contributed iron ore are included, 257 which were being prospected, or in which shafts were being sunk, or which were temporarily idle, being excluded. There have been numerous consolidations of important mines, thus reducing still further the number reported in 1902. In many instances two or three mines which were formerly operated independently have been united, connected with common shafts or slopes, and the ore usually all mined under one management. Thus, the Chapin mine, on the Menominee range in Michigan, combines what were formerly known as the Chapin, Ludington, and Hamilton mines; the Norrie mine, on the Gogebic range in Michigan, embraces the North Norrie, East Norrie, Norrie, and Pabst; and the Cary mine, on the same range in Wisconsin, represents the Cary, West Cary, and Odanah mines. Other similar consolidations in the Lake Superior and Southern districts could be mentioned.

In the 1880 census the number of establishments was reported as 805; this included a number of small operations, especially in the eastern section of the United States, which were afterwards abandoned because improved transportation facilities permitted the utilization of the richer ores of the Lake Superior district where operations on a large scale were possible.

The number of wage-earners and salaried officials was 38,227 in 1889 and 41,256 in 1902, but the compensation paid them increased from $14,409,151 in 1889 to $23,645,022 in 1902. It would appear, therefore, that the proportionate increase in the amount paid was much greater than in the number employed. This is due, in part, to the different methods used in the calculation of the average number of men employed. In 1902 the number of employees in active mines only were considered, and the average number employed during the year was reduced to correspond with the number which would be required at "continuous employment for twelve months to produce the quantity of product reported." Thus, if 200 men were employed at an open cut mine which, owing to climatic conditions, could be operated for only nine months during the year, the average number for the entire year, as determined in 1902, would be 150 instead of 200. The proportionate increase in the amount paid, therefore, is not so much greater than that in the number of employees as it might seem from the statistics.

Moreover, in the 1889 census all of the persons employed at mines which were active, or might again become active, were included. If to the number given for 1902 in Table 1 those employed in the exploitation of mines not yet shipping ore and in mines temporarily idle be added, the total number of persons employed would be increased from 41,256 to 41,551, and the wages from $23,645,022 to $23,822,339. In addition, in 1902, 1,365 men were employed by contractors in active mines and in development work, the contractors receiving $641,460.

In the year 1889 the cost of supplies and materials was $4,998,988, the amount paid in wages and salaries was $14,409,151, contract work cost $1,578,010, and miscellaneous expenses $3,795,509, a total of $24,781,658. In the year 1902 the total wages and salaries were $23,645,022, contract work cost $425,292, supplies and materials $9,005,608, miscellaneous expenses were $8,257,714, a total of $41,333,636.[1]

Table 1 indicates that in 1902 the quantity of ore mined was about five times the product in 1880, but that the value of the ore produced in 1902 was less than three times that of 1880.

The total value at the mines of the 35,567,410 long tons of iron ore produced during the year 1902 was $65,465,321, an average of $1.84 per ton. The value of the 14,518,041 long tons produced in the year 1889 was $33,351,978, or $2.30 per ton. This shows an increase in quantity of 21,049,369 long tons and in value of $32,113,343. Because of the greater use of labor-saving appliances, and other economies, resulting in part from the consolidation of contiguous mines, the average value per ton shows a reduction of 46 cents, or 20 per cent.

In the following statement the average value at the mine per ton of iron ore is presented for the census years from 1860 to 1902, inclusive. The figures for the regular mining establishments are taken for the earlier years, as the difference in total amount would make little change in the average value per ton of product.

CENSUS YEAR.	Average value at the mine per long ton of iron ore
1860	$2.69
1870	4.65
1880	3.25
1889	2.30
1902	1.84

In the earlier census years the mines were nearer the furnaces, while in the later the ore was carried long distances to points of consumption. This explains, in part, the higher value at the mines in former years.

Development work.—In connection with mining a certain amount of preparatory or exploratory work is always required. In most of the producing mines the labor, cost of supplies and materials, and miscellaneous expenses incidental to such work are charged to the regular operating expenses and do not appear separately in the reports. There are, however, in addition, a number of mines which are mere explorations or developments, not having produced any ore, or old mines which, having been abandoned, have been reopened. It is difficult to obtain accurate information in regard to the expenditures for work done preparatory to the actual shipping of the ore, especially where a company has not been organized, but such data as could be secured are summarized in the following table:

---

[1] 1902 figures are exclusive of development work.

TABLE 2.—*Development work, by states: 1902.*

	United States.	Michigan.	Minnesota.	Utah.	All other states.[1]
Number of mines	37	6	19	4	8
Number of operators	33	6	15	4	8
Salaried officials, clerks, etc.					
Number	28	9	6	3	10
Salaries	$20,715	$8,259	$2,236	$1,000	$9,220
Wage-earners:					
Total average number	267	98	117	4	48
Total wages	$156,602	$58,356	$73,700	$1,410	$20,136
Above ground—					
Average number	221	68	112	1	40
Wages	$125,383	$39,397	$70,295	$1,080	$14,621
Below ground—					
Average number	46	30	5	3	8
Wages	$31,219	$18,959	$3,405	$330	$5,515
Contract work					
Amount paid	$216,168	....	$215,868	$300	......
Number of employees	286	....	284	2	......
Miscellaneous expenses	$68,533	$63,405	$2,346	$140	$2,642
Cost of supplies and materials	$143,541	$71,691	$66,310	$2,030	$3,510

[1] Includes operators distributed as follows: Alabama, 1; California, 1; Colorado, 1; Iowa, 1; New Jersey, 1; New York, 1; Pennsylvania, 2.

Table 2 shows that there were 37 nonproductive mines engaged in development work in the United States in 1902, employing 28 salaried officials and an average of 267 wage-earners, who received $177,317; the cost of supplies and materials being $143,541 and the miscellaneous expenses $68,533. These mines were capitalized at $2,685,000.

While these figures do not represent the full amount of expenditures for this class of work during 1902, they give some idea of the expense necessary before mines become productive. The most active exploitation of new deposits was in the states of Minnesota and Michigan. In most of the older states, such as New Jersey and New York, little exploratory work was done, except by active companies; such work was included in the reports of the active mining operations of these companies.

In addition to the mines included in the above table, there were 220 mines which appear to have been entirely inactive during 1902 as regards production or development work, no expenses for such work having been reported.

The mines classed as idle should not be considered as including abandoned mines or openings which have been idle for a long time with no effort made to revive them, nor do they include mines which have been dismantled. The purpose was to add to the record statistics covering such mines or operations as may be producers in the near future.

Capital stock of incorporated companies.—It is difficult to arrive at a fair determination of the proportion of capital stock and bonds properly chargeable against iron ore mines when operated by corporations owning blast furnaces and rolling mills, coal mines, railroads, etc., or by companies subordinate to parent organizations, or where the mining property is leased. Thus, A leases an iron ore property to B, who for this lease pays either a definite sum or, more often, a fixed or sliding scale royalty per ton for the ore taken out for a given time, usually a minimum annual output being stipulated. The operations may be upon a small part of the property owned by A, but if A places a value upon it, this value would probably include the entire tract. B can fix no value for the iron ore property, being merely a lessee, and would probably base his valuation upon the royalty he pays capitalized, which will be constantly changing as the mines are worked energetically or otherwise, or as the demand for ore is active or slack. The owner or the lessee may or may not be interested in the manufacture of iron. There are cases where the mines of an iron producing company are worked under lease for the advantage of another company, because of the location of the deposit as related to the works of the owner or the lessee.

In some instances companies organized years ago with moderate capital own or control large mines or land containing reserves of ore, the properties representing many times the capital stock of the company. In one instance there is a record of a company whose dividends in one year equalled the entire capitalization of the company. On the other hand, organizations capitalized in late years have iron ore holdings of comparatively small value, or are apparently over capitalized if the market value of the stock is considered. In the state of Minnesota some mines are owned in fee simple; others are on lands belonging to the state, which issues a mining lease at a fixed royalty. Some of these mining leases were secured by parties who sold them for a lump sum varying according to the amount of ore which is believed to exist on the property, or leased the property subject to the first and also a second royalty, usually from 5 to 20 cents per ton, a minimum amount of ore being specified to be won each year. In such cases the companies operating the mines are in reality sublessees, and there are instances where a third lease has been made, and the par value of the stock may not represent anything like the true value of the ore deposit. In some of the Southern states a number of mines are worked by mining companies, who win the ore from the deposits and deliver it f. o. b. at the mine at a fixed rate, which is paid by the owners of the property, and in this case the returns from this mining company would merely represent the value of the equipment used, and would not include the value of the ore property, which may be many times greater than that of the machinery, tools, and appliances used by companies which are really contractors.

In the Southern states and in the Lake Superior region many mines are leased, the capitalization of the operating company representing merely the value of the lease and not of the land. In addition to earnings on the capital stock of the company a fixed or, in some cases, a sliding royalty is paid, which, in the latter case, is based upon the market price of the ore; this royalty value is not recognized in the capitalization.

The following table presents the details of the capitalization of the incorporated companies:

TABLE 3.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Alabama.	Colorado.	Georgia.	Maryland.	Michigan.	Minnesota.	Missouri.
Number of incorporated companies	214	27	18	9	1	41	31	5
Number reporting capitalization	183	25	18	8	1	32	26	4
Capital stock and bonds issued	$247,798,970	$22,122,470	$27,765,000	$4,274,300	$1,000,000	$96,158,000	$56,532,200	$305,000
Capital stock:								
Total authorized—								
Number of shares	12,358,397	1,237,756	6,464,150	130,520	5,000	1,585,350	848,500	63,250
Par value	$265,053,900	$19,927,600	$28,680,000	$12,419,000	$500,000	$101,340,000	$64,590,000	$335,000
Total issued—								
Number of shares	10,672,491	1,069,443	5,464,110	48,308	5,000	1,495,390	758,922	33,250
Par value	$233,933,470	$17,477,970	$27,665,000	$4,197,800	$500,000	$94,039,000	$56,532,200	$305,000
Dividends paid	$6,329,405	$420,999	$102,000			$3,270,483	$1,720,983	$40,000
Common—								
Authorized—								
Number of shares	11,700,397	1,147,956	6,464,150	114,770	5,000	1,331,350	598,100	63,250
Par value	$204,052,400	$14,823,600	$28,680,000	$11,391,500	$500,000	$76,240,000	$39,550,000	$335,000
Issued—								
Number of shares	10,126,625	1,007,656	5,464,110	32,558	5,000	1,282,870	550,002	33,250
Par value	$182,651,625	$13,693,600	$27,665,000	$3,170,300	$500,000	$73,087,000	$35,640,200	$305,000
Dividends paid	$3,183,440	$200,000	$102,000			$1,845,500	$296,000	$40,000
Preferred—								
Authorized—								
Number of shares	658,000	89,800		15,750		254,000	250,400	
Par value	$61,001,500	$5,104,000		$1,027,500		$25,100,000	$25,040,000	
Issued—								
Number of shares	545,866	61,787		15,750		212,520	208,920	
Par value	$51,281,845	$3,784,370		$1,027,500		$20,952,000	$20,892,000	
Dividends paid	$3,145,965	$220,999				$1,424,983	$1,424,983	
Bonds:								
Authorized—								
Number	47,607	5,239	100	753	500	10,900		
Par value	$22,647,500	$5,239,500	$100,000	$203,000	$500,000	$10,350,000		
Issued—								
Number	37,363	4,644	100	189	500	2,969		
Par value	$13,565,500	$4,644,500	$100,000	$76,500	$500,000	$2,119,000		
Interest paid	$521,111	$268,291				$5,250		
Assessments levied	$64,300							

	New Jersey.	New York.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	Wisconsin.	All other states.
Number of incorporated companies	7	10	5	12	9	18	7	[1] 11
Number reporting capitalization	7	10	5	11	9	11	6	[2] 10
Capital stock and bonds issued	$5,988,400	$10,129,900	$598,000	$5,464,225	$1,040,000	$5,702,600	$7,335,375	$3,083,500
Capital stock:								
Total authorized—								
Number of shares	63,750	90,200	5,475	58,326	9,480	70,650	300,200	1,425,400
Par value	$5,745,000	$8,995,000	$650,000	$4,381,300	$948,000	$6,065,000	$7,520,000	$2,969,000
Total issued—								
Number of shares	54,784	85,849	4,995	39,614	8,950	56,026	292,815	1,225,135
Par value	$5,388,400	$8,559,900	$587,500	$2,614,225	$895,000	$5,102,600	$7,335,375	$2,733,500
Dividends paid	$75,000	$314,021		$43,579		$52,500	$280,000	$9,840
Common—								
Authorized—								
Number of shares	38,150	75,200	5,475	57,126	9,480	64,400	300,200	1,425,400
Par value	$3,185,000	$7,495,000	$650,000	$4,336,300	$948,000	$5,440,000	$7,520,000	$2,969,000
Issued—								
Number of shares	29,184	70,849	4,995	38,575	8,950	50,776	292,815	1,225,135
Par value	$2,828,400	$7,059,900	$587,500	$2,573,250	$895,000	$4,577,600	$7,335,375	$2,733,500
Dividends paid		$314,021		$43,579		$52,500	$280,000	$9,840
Preferred—								
Authorized—								
Number of shares	25,600	15,000		1,200		6,250		
Par value	$2,560,000	$1,500,000		$45,000		$625,000		
Issued—								
Number of shares	25,600	15,000		1,039		5,250		
Par value	$2,560,000	$1,500,000		$40,975		$525,000		
Dividends paid	$75,000							
Bonds:								
Authorized—								
Number	1,000	2,675	70	25,371	145	504		350
Par value	$600,000	$1,675,000	$35,000	$2,850,000	$145,000	$600,000		$350,000
Issued—								
Number	1,000	1,570	21	25,371	145	504		350
Par value	$600,000	$1,570,000	$10,500	$2,850,000	$145,000	$600,000		$350,000
Interest paid		$63,500	$420	$141,150		$25,000		$17,500
Assessments levied					$62,000	$1,800		$500

[1] Includes companies distributed as follows: Connecticut, 1; Kentucky, 3; Massachusetts, 1; Montana, 2; North Carolina, 3; Texas, 1; Utah, 2; Wyoming, 1.
[2] Includes companies distributed as follows: Connecticut, 1; Kentucky, 3; Massachusetts, 1; Montana, 1; North Carolina, 1; Texas, 1; Utah, 2.

In the statistics presented in Table 3, where the iron ore lands were owned by companies operating blast furnaces, steel mills, or other industrial enterprises, an effort was made to secure an approximate proportion of the capitalization which would properly be chargeable against the iron ore mines, but without success, and in such cases the statistics are for the entire capitalization of the company.

The table shows that a large proportion, 64.7 per cent, of the capitalization of stock and bonds was reported from the iron mines in Michigan, Minnesota, and Wisconsin, which, with the exception of a few outlying mines, are embraced in the Lake Superior region. These three states produced 76.1 per cent of all the ore mined in 1902.

Next to the Lake Superior region, Colorado shows the largest capitalization, but much of the iron won in that state is from mines of the precious metal. In some instances this argentiferous iron ore is the only mineral at present won from the operation, and there-

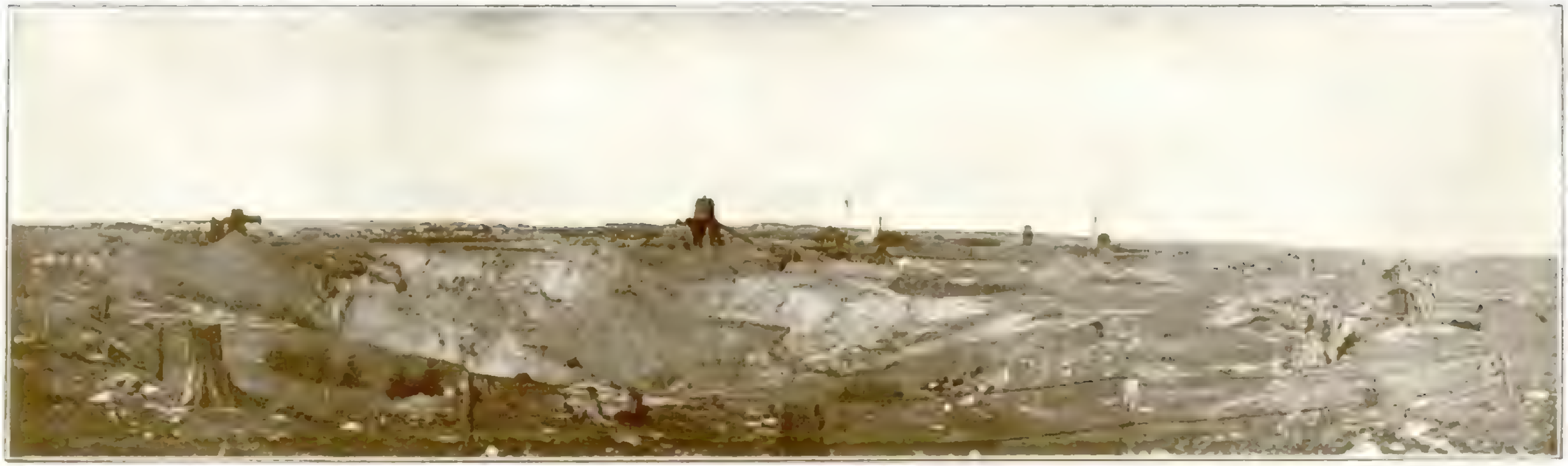

PLATE I.—PIONEER AND CHANDLER MINES AT ELY, MINNESOTA

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fore the entire capitalization (originally based on the supposed value of the mine as a precious metal producer) is included in the iron ore report.

Alabama ranks next to the Lake Superior region and Colorado in the capitalization, as would naturally be expected from the large amount of iron ore produced. New York, New Jersey, Virginia, Pennsylvania, and Georgia follow in the order named, the remaining states being comparatively unimportant, so far as the capitalization of their iron mining companies is concerned.’

In the year 1902 the capitalization, including funded debt, of 183 incorporated companies owning active iron ore mines reached a total of $247,798,970. In the year 1889 returns were secured from the 592 different mines of the value of the land, buildings and fixtures, tools and implements, and the amount of cash and stock on hand, showing a total of $109,766,199. Therefore, no information of comparative value is obtainable from a study of the reports of the capital invested in iron ore mines at the two census periods.

Employees and wages.—The following table shows the average number of wage-earners employed during each month in iron ore mining, by states and territories:

TABLE 4.—AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH, BY STATES AND TERRITORIES: 1902.

	United States.	Alabama.	Colorado.	Georgia.	Maryland.	Michigan.	Minnesota	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	Wisconsin.	All other states and territories.[1]
Total average number	38,851	4,864	418	688	76	14,456	8,256	148	1,660	965	111	1,140	1,299	2,686	1,361	723
Average number of men 16 years and over	38,333	4,738	418	647	64	14,446	8,254	147	1,655	963	111	1,118	1,205	2,493	1,354	720
January	33,854	4,358	437	562	30	13,415	6,210	108	1,453	965	34	1,074	1,126	2,136	1,393	553
February	33,196	4,403	428	559	30	12,858	6,198	113	1,535	862	69	1,021	1,113	2,104	1,372	590
March	34,714	4,616	425	644	80	13,373	6,416	113	1,580	928	112	990	1,134	2,337	1,355	611
April	36,829	4,665	433	659	75	13,940	7,370	134	1,684	1,007	116	1,076	1,208	2,396	1,398	678
May	39,291	4,698	409	670	83	14,803	8,449	147	1,732	959	125	1,102	1,250	2,664	1,429	776
June	39,311	4,715	413	673	47	14,399	8,759	153	1,769	969	158	1,100	1,271	2,692	1,403	780
July	40,594	4,850	390	661	92	14,977	9,102	182	1,775	894	141	1,229	1,257	2,845	1,392	907
August	41,426	4,887	406	664	85	15,340	9,456	182	1,762	978	137	1,179	1,271	2,846	1,421	812
September	41,259	4,861	412	647	83	15,441	9,659	164	1,694	948	104	1,184	1,217	2,718	1,336	793
October	40,958	4,987	407	630	72	15,449	9,449	156	1,647	1,019	121	1,153	1,225	2,577	1,340	720
November	39,859	4,939	437	705	50	14,911	9,306	156	1,617	996	127	1,159	1,195	2,318	1,227	715
December	38,706	4,892	419	690	41	14,440	8,672	156	1,612	1,013	89	1,150	1,198	2,293	1,181	863
Average number of boys under 16 years	518	126	......	41	12	10	2	1	5	2	......	22	94	193	7	3
January	405	113	......	33	2	7	2	......	5	2	......	10	85	141	2	3
February	[illegible]	102	......	40	2	6	2	......	5	2	......	10	86	137	2	3
March	454	118	......	35	18	6	2	......	5	2	......	10	88	164	[illegible]	2
April	497	109	......	41	10	8	2	1	5	2	......	29	93	189	6	2
May	539	117	......	36	13	8	2	1	5	2	......	29	101	216	6	3
June	531	114	......	38	4	10	2	1	5	2	......	30	102	212	8	3
July	573	124	......	43	17	11	2	1	5	2	......	30	94	230	11	3
August	599	143	......	41	16	13	2	1	5	2	......	34	98	228	12	4
September	598	143	......	46	18	14	2	1	5	2	......	31	99	224	9	4
October	570	141	......	48	16	13	2	2	5	2	......	23	93	211	10	4
November	542	147	......	45	16	13	2	2	5	2	......	15	96	190	8	1
December	511	141	......	46	12	11	2	2	5	2	......	13	93	174	6	4

[1] Includes operators distributed as follows: Connecticut, 1; Kentucky, 3; Massachusetts, 1; Montana, 3; New Mexico, 1; North Carolina, 2; Texas, 1; Utah, 4; Vermont, 1; West Virginia, 1.

These statistics show practically steady employment in such states as Alabama, Georgia, Tennessee, and Virginia, where the climatic conditions do not interfere with mining operations; and even in the states of Minnesota, Michigan, and Wisconsin, the variation in the number employed was less than generally presumed to be the case. This was undoubtedly due to the fact that the demand for ore encouraged a considerable amount of "dead work" and underground exploitation during the winter months. It is probable that figures for the year 1903 would show considerably greater variation between the seasons than those for 1902.

While the states of Minnesota and Michigan produced 76.7 per cent of the iron ore mined in the United States in 1902, the average number of wage-earners in those states represented only 58.5 per cent of the total for the country, and a calculation shows that for each wage-earner in those states 1,156 tons of iron ore were produced. Similar estimates for important producing states and for the country appear in the following table, to which the figures for 1889 have been added for the purpose of comparison:

TABLE 5.—*Tons of iron ore produced per wage-earner, by states: 1902 and 1889.*

STATE.	1902			1889		
	Quantity produced (long tons).	Number of wage-earners	Tons of ore per wage-earner.	Quantity produced (long tons).	Number of wage-earners	Tons of ore per wage-earner.
United States	35,567,410	38,851	915	14,518,041	36,341	399
Minnesota	15,137,650	8,256	1,834	864,508	1,697	509
Michigan	11,135,215	14,456	770	5,856,169	12,406	469
Alabama	3,571,474	4,864	735	1,570,319	3,019	520
Virginia and West Virginia	[1] 973,301	[1] 2,686	362	511,255	2,307	222
Tennessee	874,542	1,299	673	473,294	1,478	320
Pennsylvania	822,932	1,140	722	1,560,234	4,219	370
Wisconsin	783,996	1,361	576	837,399	1,737	482
New York	555,321	965	575	1,247,537	3,011	414
New Jersey	441,879	1,660	266	415,510	1,790	233
Georgia and North Carolina	[2] 330,354	[2] 688	480	258,145	736	351
Colorado	306,572	418	733	109,136	366	298
Missouri	66,308	148	448	265,718	678	392
Ohio	22,697	111	204	254,294	1,565	162
All other states and territories	[3] 542,009	[3] 799	678	[4] 294,523	[4] 1,252	235

[1] Includes Virginia only.

[2] Includes Georgia only.

[3] Includes Connecticut, Kentucky, Maryland, Massachusetts, Montana, New Mexico, North Carolina, Texas, Utah, Vermont, West Virginia, and Wyoming.

[4] Includes Connecticut, Delaware, Idaho, Kentucky, Maine, Maryland, Massachusetts, Montana, New Mexico, Oregon, Texas, Utah, and Washington.

It should be pointed out, in connection with the foregoing table, that the increase in 1902 over 1889 in the productive capacity per wage-earner is probably considerably less than is indicated by the figures, owing to the difference in the method of computing the average number of wage-earners at the two censuses.

An analysis of the statistics of wage-earners presents some interesting features. In Table 14, showing the detailed statistics, it will be noted that out of a total of 38,851 wage-earners, 23,082 are reported as employed below ground. That is, of the total number of wage-earners engaged in the iron ore industry 59.4 per cent are employed below the surface, the remainder being engaged upon surface mining or upon the work above ground. It is also shown that out of a total of 38,851, those returned as miners and miners' helpers, number 20,849, which suggests that slightly over one-half of those engaged in the iron ore industry may be considered as actually digging the ore.

As already stated, exact comparisons between the number of wage-earners at the Eleventh and Twelfth censuses can not be made, by reason of the fact that in 1902 the number of employees was reduced to the basis of practically continuous work (300 days) during the year. However, out of a total of 37,707 employees reported in 1889, 19,708 were returned as working below ground. The miners and laborers below ground, who may be considered as representing miners and miners' helpers, showed a total of 18,911 in 1889. The miners engaged in large open-cut operations were classed as laborers, and if the number of these be added to the above total, and this again corrected for the employees who were not actually helpers, the resulting figure indicates that practically the same ratio held good in 1889 as in 1902, namely, that about one-half of the wage-earners at iron ore mines may be considered as having actually dug the ore.

Table 14 shows also that a number of the miners worked above ground, and that a large proportion of the unclassified labor was employed below the surface. The unclassified labor represented about 29.9 per cent of all those engaged in the iron ore industry. This is accounted for by the fact that in a number of the large open-cut mines, where the operations were carried on by steam shovel, the only skilled help was really those engaged in the handling of machinery, trains, etc.

Table 6 shows for 1902 the distribution of wage-earners according to daily rates of pay, by states.

TABLE 6.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY STATES AND TERRITORIES: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			ALABAMA.			MICHIGAN.			MINNESOTA.			NEW JERSEY.			NEW YORK.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	[1]38,851	100.0	....	4,864	100.0	....	14,456	100.0	....	8,256	100.0	....	1,660	100.0	....	965	100.0	....
Less than 0.50	141	0.4	100.0	21	0.4	100.0	....	....	....	1	(2)	100.0	....	....	....	....	....	....
0.50 to 0.74	279	0.7	99.6	87	1.8	99.6	1	(2)	100.0	....	....	99.9	6	0.4	100.0	....	....	....
0.75 to 0.99	853	2.2	98.9	209	4.3	97.8	12	0.1	99.9	....	....	99.9	3	0.2	99.6	2	0.2	100.0
1.00 to 1.24	4,618	11.9	96.7	1,239	25.5	93.5	50	0.4	99.9	11	0.1	99.9	47	2.8	99.4	170	17.6	99.8
1.25 to 1.49	2,874	7.4	84.8	743	15.3	68.0	148	1.0	99.5	17	0.2	99.9	391	23.6	96.6	219	22.7	82.2
1.50 to 1.74	5,468	14.1	77.4	1,504	30.9	52.7	1,622	11.2	98.5	211	2.6	99.7	693	41.7	73.0	448	46.4	59.5
1.75 to 1.99	7,344	18.9	63.3	858	17.6	21.8	3,614	25.0	87.3	1,763	21.1	97.1	433	26.1	31.3	64	6.7	13.1
2.00 to 2.24	8,535	22.0	44.4	169	3.5	4.2	4,132	28.6	62.3	3,404	41.2	75.7	57	3.4	5.2	36	3.7	6.4
2.25 to 2.49	4,862	12.5	22.4	5	0.1	0.7	3,156	21.8	33.7	1,361	16.5	34.5	25	1.5	1.8	14	1.5	2.7
2.50 to 2.74	2,511	6.4	9.9	23	0.5	0.6	1,421	9.8	11.9	867	10.5	18.0	5	0.3	0.3	5	0.5	1.2
2.75 to 2.99	630	1.6	3.5	1	(2)	0.1	184	1.3	2.1	390	4.7	7.5	....	....	....	3	0.3	0.7
3.00 to 3.24	454	1.2	1.9	5	0.1	0.1	74	0.5	0.8	93	1.1	2.8	....	....	....	3	0.3	0.4
3.25 to 3.49	77	0.2	0.7	....	....	....	13	0.1	0.3	44	0.5	1.7	....	....	....	....	....	0.1
3.50 to 3.74	125	0.3	0.5	....	....	....	18	0.1	0.2	54	0.7	1.2	....	....	....	....	....	0.1
3.75 to 3.99	7	(2)	0.2	....	....	....	2	(2)	0.1	4	(2)	0.5	....	....	....	....	....	0.1
4.00 to 4.24	30	0.1	0.2	....	....	....	7	0.1	0.1	7	0.1	0.5	....	....	....	1	0.1	0.1
4.25 and over	43	0.1	0.1	....	....	....	2	(2)	(2)	29	0.4	0.4	....	....	....	....	....	....

RATE PER DAY (DOLLARS).	PENNSYLVANIA.			TENNESSEE.			VIRGINIA.			WISCONSIN.			ALL OTHER STATES AND TERRITORIES.[3]		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	1,140	100.0	....	1,299	100.0	....	2,686	100.0	....	1,361	100.0	....	2,164	100.0	....
Less than 0.50	8	0.7	100.0	2	0.2	100.0	96	3.6	100.0	....	....	....	13	0.6	100.0
0.50 to 0.74	10	0.9	99.3	48	3.7	99.8	80	3.0	96.4	....	....	....	47	2.2	99.4
0.75 to 0.99	57	5.0	98.4	258	19.9	96.1	146	5.4	93.4	4	0.3	100.0	162	7.5	97.2
1.00 to 1.24	411	36.1	93.4	440	33.9	76.2	1,593	59.3	88.0	4	0.3	99.7	653	30.2	89.7
1.25 to 1.49	336	29.5	57.3	113	8.7	42.3	579	21.6	28.7	14	1.0	99.4	314	14.5	59.5
1.50 to 1.74	240	21.0	27.8	244	18.8	33.6	123	4.6	7.1	105	7.7	98.4	278	12.8	45.0
1.75 to 1.99	28	2.4	6.8	11	0.8	14.8	22	0.8	2.5	451	33.1	90.7	100	4.6	32.2
2.00 to 2.24	23	2.0	4.4	20	1.5	14.0	28	1.0	1.7	582	42.8	57.6	84	3.9	27.6
2.25 to 2.49	8	0.7	2.4	121	9.3	12.5	6	0.2	0.7	153	11.2	14.8	13	0.6	23.7
2.50 to 2.74	2	0.2	1.7	39	3.0	3.2	8	0.3	0.5	39	2.9	3.6	102	4.7	23.1
2.75 to 2.99	17	1.5	1.5	....	....	0.2	4	0.2	0.2	6	0.4	0.7	25	1.1	18.4
3.00 to 3.24	....	....	....	3	0.2	0.2	1	(2)	(2)	....	....	0.3	275	12.7	17.3
3.25 to 3.49	....	....	....	....	....	....	....	....	....	1	0.1	0.3	19	0.9	4.6
3.50 to 3.74	....	....	....	....	....	....	....	....	....	....	....	0.2	53	2.5	3.7
3.75 to 3.99	....	....	....	....	....	....	....	....	....	1	0.1	0.2	....	....	1.2
4.00 to 4.24	....	....	....	....	....	....	....	....	....	1	0.1	0.1	14	0.6	1.2
4.25 and over	....	....	....	....	....	....	....	....	....	....	....	....	12	0.6	0.6

[1] Includes 8,106 wage-earners, paid by the ton, for whom average daily earnings are shown.

[2] Less than one-tenth of 1 per cent.

[3] Includes Colorado, Connecticut, Georgia, Kentucky, Maryland, Massachusetts, Missouri, Montana, New Mexico, North Carolina, Ohio, Texas, Utah, Vermont, West Virginia, and Wyoming.

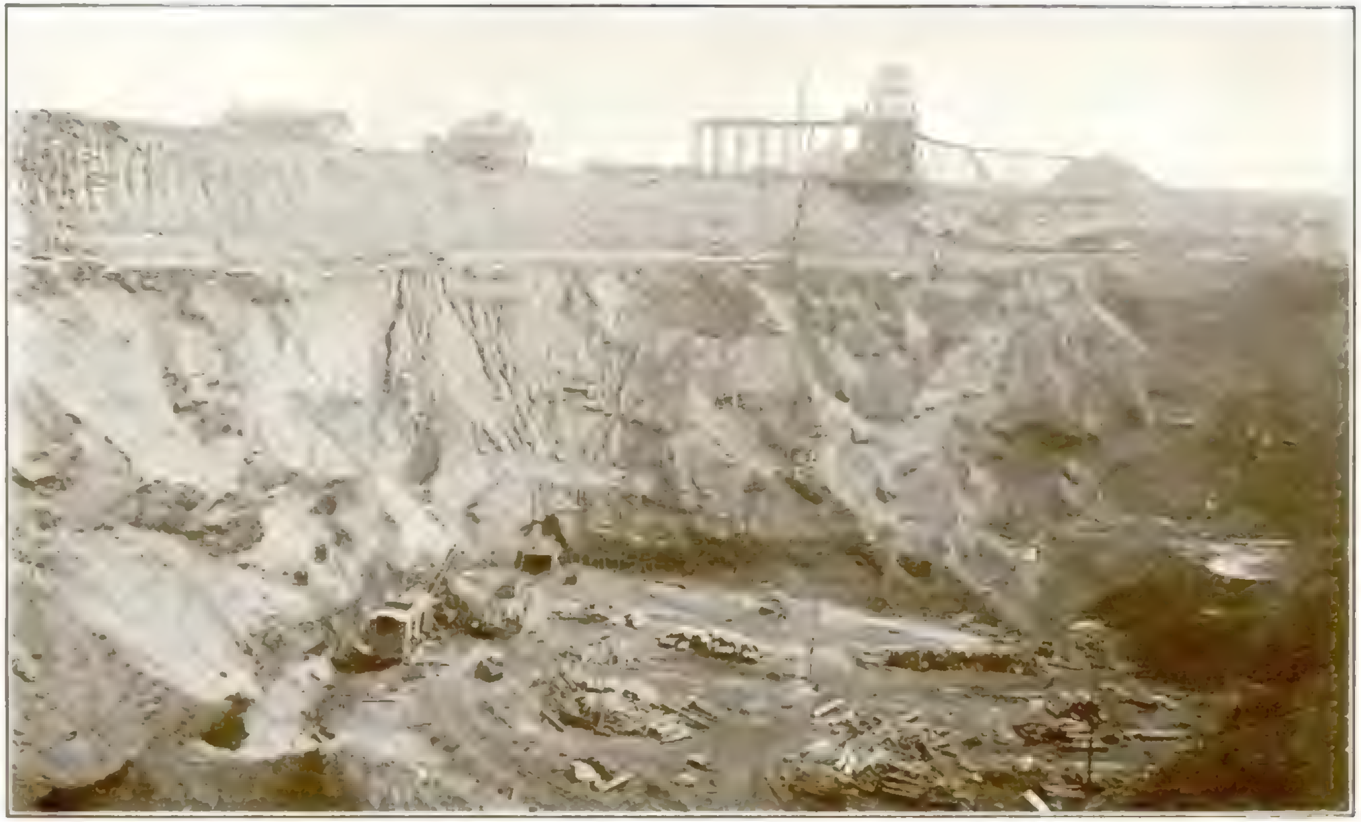

PLATE II.—AUBURN MINE, MILLING PIT, MESABI RANGE, MINNESOTA.

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In the preceding table the distribution of wage-earners, according to daily rates of pay, is shown separately for the 8 states which reported more than 1,000 wage-earners, and also for New York, which is the only other state in which the number of wage-earners approximated 1,000. These 9 states gave employment to 36,687 wage-earners, or 94.4 per cent of the total number employed in this industry in the United States. Of the states for which statistics are presented separately, Minnesota shows the highest rates of pay, 97.1 per cent of the wage-earners having received at least $1.75 per day, and 34.5 per cent of these $2.25 per day or over. The rates of pay were only slightly lower in Michigan and Wisconsin. In the former state 11.2 per cent received between $1.50 and $1.74, while in Wisconsin the proportion with rates of $2.25 or over was considerably smaller than in Minnesota. Michigan, Minnesota, and Wisconsin constitute the Lake Superior district, and the rates in these 3 states were materially higher than those in the other states. In each of the 3 states of the Lake Superior district the bulk of the wage-earners received $2 per day or over, while in each of the other states for which statistics are shown separately, practically all the wage-earners received less than $2 per day.

The state in which the daily rates of pay approached most nearly those of the Lake Superior district is New Jersey, where the range of wages for 91.4 per cent of the employees was from $1.25 to $1.99. New York, Alabama, Pennsylvania, and Wisconsin follow in the order named. New York shows a considerable number with rates of less than $1.25 per day and a comparatively small number who received as much as $1.75. In Alabama the bulk of the wage-earners, 89.3 per cent, received between $1 and $1.99. There was very little difference on the whole between the rates paid in Pennsylvania and those paid in Tennessee. The proportion receiving $1.75 or over was greater in Tennessee, but the number who received less than $1 was so large as to offset this. Rates were lower on the whole in Virginia than in any other state which reported a large number of wage-earners, only 7.1 per cent of the total number having been paid as much as $1.50 to $1.74 per day.

Table 7 shows the distribution of the wage-earners employed in 1902 in the mining of iron ore among the several occupations and according to daily rates of pay. For each occupation the average number employed during the year at specified rates, and the percentages which these numbers form of the total number, are given. In an additional column these percentages are accumulated, thus rendering it possible to determine what proportion of the total number received as much as, or more than, a given rate.

TABLE 7.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL CLASSES.			ENGINEERS.			FIREMEN.			MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.			MINERS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total	Cumulative percentage.	Average number.	Per cent of total	Cumulative percentage.
Total	[1]38,851	100.0	....	1,102	100.0	....	812	100.0	....	1,842	100.0	....	18,556	100.0	....
Less than 0.50	141	0.4	100.0	......	......	......	......	......	......	......	......	......	13	0.1	100.0
0.50 to 0.74	279	0.7	99.6	......	......	......	1	0.1	100.0	......	......	......	296	1.6	99.9
0.75 to 0.99	853	2.2	98.9	......	......	......	3	0.4	99.9	3	0.2	100.0	3,001	16.2	98.3
1.00 to 1.24	4,618	11.9	96.7	21	1.9	100.0	49	6.0	99.5	36	2.0	99.8	1,057	5.7	82.1
1.25 to 1.49	2,874	7.4	84.8	91	8.3	98.1	135	16.6	93.5	108	5.9	97.8	2,478	13.4	76.4
1.50 to 1.74	5,468	14.1	77.4	168	15.3	89.8	76	9.4	76.9	206	11.2	91.9	1,585	8.5	63.0
1.75 to 1.99	7,344	18.9	63.3	239	21.7	74.5	312	38.4	67.5	341	18.5	80.7	3,926	21.2	54.5
2.00 to 2.24	8,535	22.0	44.4	378	34.3	52.8	183	22.5	29.1	502	27.2	62.2	3,642	19.6	33.3
2.25 to 2.49	4,862	12.5	22.4	84	7.6	18.5	37	4.5	6.6	290	15.7	35.0	1,687	9.1	13.7
2.50 to 2.74	2,511	6.4	9.9	23	2.1	10.9	9	1.1	2.1	186	10.1	19.3	481	2.6	4.6
2.75 to 2.99	630	1.6	3.5	7	0.6	8.8			1.0	63	3.4	9.2	304	1.6	2.0
3.00 to 3.24	454	1.2	1.9	25	2.3	8.2	3	0.4	1.0	52	2.8	5.8	24	0.1	0.4
3.25 to 3.49	77	0.2	0.7	9	0.8	5.9	2	0.3	0.6	12	0.7	3.0	55	0.3	0.3
3.50 to 3.74	125	0.3	0.5	17	1.5	5.1	2	0.3	0.3	27	1.5	2.3	2	(2)	(2)
3.75 to 3.99	7	(2)	0.2	1	0.1	3.6	......	......	......	2	0.1	0.8	......	......	......
4.00 to 4.24	80	0.1	0.2	10	0.9	3.5	......	......	......	10	0.5	0.7	5	(2)	(2)
4.25 and over	43	0.1	0.1	29	2.6	2.6	......	......	......	4	0.2	0.2			

RATE PER DAY (DOLLARS).	MINERS' HELPERS.			TIMBERMEN AND TRACK LAYERS.			BOYS UNDER 16 YEARS.			ALL OTHER WAGE-EARNERS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	2,293	100.0	....	2,099	100.0	....	518	100.0	....	11,629	100.0	....
Less than 0.50	......	......	......	......	......	......	141	27.2	100.0	......	......	......
0.50 to 0.74	......	......	......	......	......	......	250	48.3	72.8	15	0.1	100.0
0.75 to 0.99	13	0.6	100.0	5	0.2	100.0	99	19.1	24.5	434	3.7	99.9
1.00 to 1.24	151	6.6	99.4	29	1.4	99.8	17	3.3	5.4	1,314	11.3	96.2
1.25 to 1.49	194	8.5	92.8	86	4.1	98.4	8	1.5	2.1	1,195	10.3	84.9
1.50 to 1.74	503	21.9	84.3	121	5.7	94.3	3	0.6	0.6	1,913	16.5	71.6
1.75 to 1.99	618	26.9	62.4	667	31.8	88.6	......	......	......	3,582	30.8	58.1
2.00 to 2.24	645	28.1	35.5	607	28.9	56.8	......	......	......	2,294	19.7	27.3
2.25 to 2.49	105	4.6	7.4	245	11.7	27.9	......	......	......	459	3.9	7.6
2.50 to 2.74	38	1.7	2.8	317	15.1	16.2	......	......	......	251	2.2	3.7
2.75 to 2.99	10	0.4	1.1	4	0.2	1.1	......	......	......	65	0.6	1.5
3.00 to 3.24	[illegible]	0.7	0.7	2	0.1	0.9	......	......	......	52	0.5	0.9
3.25 to 3.49	......	......	......	2	0.1	0.8	......	......	......	28	0.2	0.4
3.50 to 3.74	......	......	......	14	0.7	0.7	......	......	......	10	0.1	0.2
3.75 to 3.99	......	......	......	......	......	......	......	......	......	2	(2)	0.1
4.00 to 4.24	......	......	......	......	......	......	......	......	......	10	0.1	0.1
4.25 and over	......	......	......	......	......	......	......	......	......	5	(2)	(2)

---

[1] Includes 8,105 wage-earners paid by the ton, for whom average daily earnings are shown.

[2] Less than one-tenth of 1 per cent.

More than half, 52.8 per cent, of the total number of engineers received $2 or over. Most of the engineers are, however, concentrated in the $2 group, and the two groups below, 71.3 per cent, receiving between $1.50 and $2.24. The wages for firemen are seen to be somewhat lower than those for engineers. For firemen the lower-limit median rate group is $1.75, while for engineers it is $2; in each case a greater number of employees is included in the median group than in any other.

The range of wages for over 82 per cent of machinists was from $1.50 to $2.74. The median rate lies between $2 and $2.24, and the distribution both above and below that rate is comparatively regular. In this occupation, also, the median group comprises a greater number of men than is found at any other rate.

The table shows a very wide range in the rates paid to miners. The wages for the bulk of the employees ranged from $1 to $2.74, with the median at $2. By far the greater portion of miners' helpers are concentrated in three wage groups, the range for 76.9 per cent being from $1.50 to $2.24.

The median wage for timbermen and track layers was between $2 and $2.24, and the bulk of the employees received from $1.50 to $2.74.

Almost half of the boys employed, 48.3 per cent, received between 50 cents and 75 cents; 27.2 per cent received less than 50 cents, and 19.1 per cent received between 75 cents and $1. The median rate for all other wage-earners was between $1.75 and $1.99. The wages for 92.3 per cent of the total number ranged from 75 cents to $2.24.

In the year 1889, also, data in regard to the wages paid the different classes of labor, both above and below ground, were obtained. The returns were in the form of average daily wages and may be summarized as follows:

OCCUPATION.	Average wages per day above ground.	OCCUPATION.	Average wages per day below ground.
Foremen and overseers	$2.40	Foremen and overseers	$2.46
Mechanics	1.90	Miners	1.91
Laborers	1.29	Laborers	1.40
Boys under 16 years	0.62	Boys under 16 years	0.82

Mechanical power.—The detailed summary shows that 119,558 horsepower was used at iron ore mines in the various operations requiring power. This power was applied chiefly through 1,132 steam engines, with a horsepower of 102,878, or 86 per cent of the total. There were also 11 gas or gasoline engines with a horsepower of 86, 11 water wheels having a horsepower of 1,010, and 260 miscellaneous appliances with a horsepower of 15,444. In addition to this primary power 35 electric motors were used, their total horsepower being 937; 140 horsepower was rented to other establishments.

At the census of 1889, 1,109 steam boilers, with a total horsepower capacity of 57,976, were reported by iron ore mines. It was stated in the report on iron ore at that census that these boilers furnished steam to 1,093 steam engines, including air compressors, hoisting machinery, and engines for driving washeries, etc. In 1902 the mechanical power was applied for the purposes for which power is commonly employed in mining work, namely, for hoisting the ore from the shaft, for subsequent beneficiating treatment, for operating steam shovels and dredges in open-cut mining, pumping and ventilating machinery, mechanical haulage, air compressors, electric lighting, drills, etc.

Table 14 shows also the distribution of the power among the several states: Michigan led in the horsepower employed, having 47,395 horsepower, or 39.6 per cent of the total; Minnesota had 25,332 horsepower, or 21.2 per cent of the total; Alabama, 10,370 horsepower, or 8.7 per cent; New Jersey, 6,684 horsepower, or 5.6 per cent; and New York, 6,015, or 5 per cent. In the other states the amount of mechanical power used was smaller, but on the whole proportionate to the extent of their operations.

Production.—At the Eighth and Ninth censuses the statistics of production were not collected in the same manner as in subsequent census years. In 1860 the number of tons of iron ore mined by the owners of blast furnaces was reported separately from the production of what were considered strictly mining companies. The report shows that the blast furnace establishments used 2,309,975 short tons in 1860, and that in addition 908,300 short tons were produced by mining companies, a total of 3,218,275 short tons, equivalent to 2,873,460 long tons.

In 1870 the total amount of iron ore produced by the mines reporting was 3,395,718 short tons, equivalent to 3,031,891 long tons; in addition some ore was produced by the owners of blast furnaces which the Bureau of the Census estimated at from 800,000 to 900,000 long tons, so that, taking the first-named figure, at least 3,831,891 long tons of iron ore were mined in 1870. At the Tenth, Eleventh, and Twelfth censuses the data were obtained from all mines irrespective of their ownership or their relation to blast furnaces. The following statement gives a comparison of the figures for these censuses:

Production of iron ore: 1860 to 1902.

CENSUS YEAR.	Quantity (long tons).
1860	2,873,460
1870	3,831,891
1880	7,120,362
1889	14,518,041
1902	35,567,410

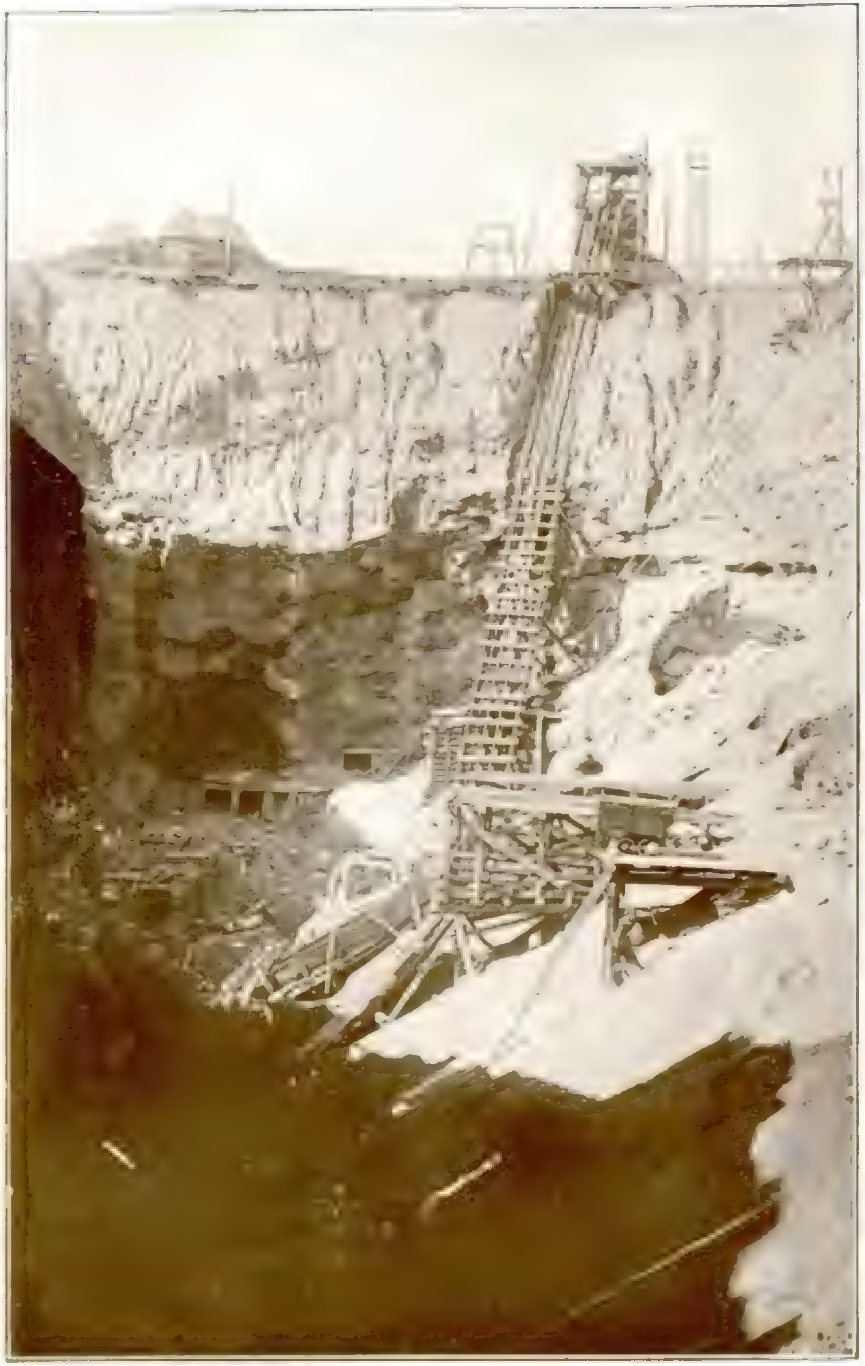

PLATE III.—NO. 2 PIT, ADAMS MINE, EVELETH, MINNESOTA.

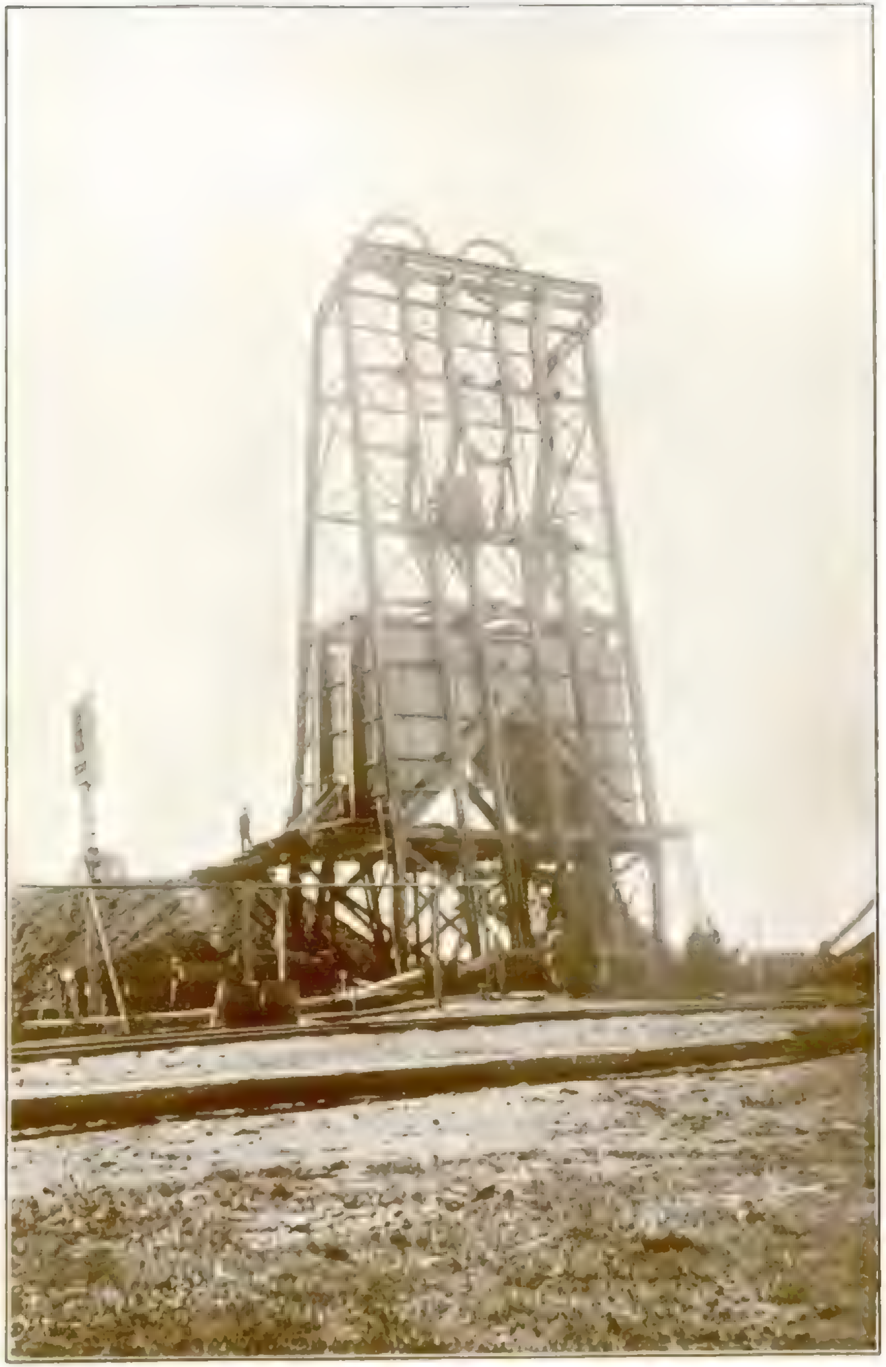

PLATE IV.—STEEL SHAFT HOUSE, ADAMS MINE. FIRST ON THE MESABI RANGE.

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There is, as mentioned, some uncertainty in regard to the production of iron ore at the Eighth and Ninth censuses, but in comparing the statistics of the various censuses it will be noted that the production in 1880 was nearly double that of 1870, while in 1889 the output was twice that of 1880. In 1900, according to the figures of the United States Geological Survey (the census of 1902 was taken at a time thirteen years removed from 1889), the proportion over 1889 was almost identical. Thus, in every decade since 1870 the production of iron ore in the United States has practically been doubled.

The following table presents for each class of iron ore the amount produced in the census years 1902, 1889, and 1880, together with the percentages which these amounts formed of the total for all classes:

Table 8.—*Production of iron ores by varieties, with per cent of total: 1902, 1889, and 1880.*

VARIETY	1902		1889		1880	
	Quantity (long tons).	Per cent of total.	Quantity (long tons).	Per cent of total.	Quantity (long tons).	Per cent of total.
Total	35,567,410	100.0	14,518,041	100.0	7,120,362	100.0
Red hematite	30,532,149	85.9	9,056,288	62.4	2,243,993	31.5
Brown hematite	[1]3,318,759	9.3	2,523,087	17.4	1,918,622	26.9
Magnetite	1,688,860	4.7	2,506,415	17.2	2,134,276	30.0
Carbonate	27,642	0.1	432,251	3.0	823,471	11.6

[1] Includes 13,275 tons of manganiferous ore.

There has been an increasing preference for rich and easily smelted iron ores, and considering the different varieties of ore, it will be found that the amount of red hematite reported in 1880 was but 31.5 per cent; in 1889, 62.4 per cent; and in 1902, 85.9 per cent of the total output. The brown hematite, although augmenting in the amounts mined, indicates a decided decrease in percentages of the total; from 1,918,622 long tons in 1880 this class of ore increased to 2,523,087 long tons in 1889 and 3,305,484 long tons in 1902, the percentages at the three censuses being respectively 26.9, 17.4, and 9.3 per cent. On the other hand, the magnetites and carbonates have shown a decline, not only in total production, but also in percentage. The former contributed 30 per cent (2,134,276 tons) of the total in 1880, 17.2 per cent (2,506,415) in 1889, and 4.7 per cent (1,688,860) in 1902. The carbonate ore has fallen from 823,471 long tons, 11.6 per cent, in 1880 to but 27,642 tons, one-tenth of 1 per cent, of the total in 1902.

The production of iron ore of the different varieties, by states, in the year 1902 was as follows:

Table 9.—*Production of iron ore, by states and territories and varieties: 1902.*

[Long tons.]

STATE OR TERRITORY.	Total.	Red hematite.	Brown hematite.	Magnetite.	Carbonate.
United States	35,567,410	30,532,149	[1]3,318,759	1,688,860	27,642
Minnesota	15,137,650	15,137,650			
Michigan	11,135,215	11,079,124		56,091	
Alabama	3,574,474	2,565,635	1,008,839		
Virginia and West Virginia	987,958	31,677	953,128	3,153	
Tennessee	874,542	370,643	503,899		
Pennsylvania	822,932	20,441	185,846	616,645	
Wisconsin	783,996	758,316	25,680		
New York	555,321	91,075	12,676	451,570	
New Jersey	441,879			441,879	
Georgia and North Carolina	364,890	117,812	216,242	30,836	
Montana, New Mexico, Utah, and Wyoming	362,034	255,269	18,079	88,686	
Colorado	306,572	4,375	[1]302,197		
Kentucky	71,006	42,195	28,811		
Missouri	66,308	57,937	8,371		
Connecticut, Massachusetts, and Vermont	29,693		29,693		
Maryland	24,367		19,382		4,985
Ohio	22,657				22,657
Texas	6,516		6,516		

[1] Includes 13,275 tons of manganiferous iron ore used in the manufacture of spiegeleisen.

Considering the individual states it is evident that those located in the Lake Superior region and in the Southern and Western states have shown an almost constant increase. In the Middle Atlantic and New England states, however, the bog, brown hematite, fossil, and magnetite ores, which formerly were the chief reliance of the local blast furnaces, have been replaced by the richer Lake Superior ores, and therefore show a marked falling off. The states will be considered in the order of their prominence in 1902.

Minnesota.—This state in 1902 contributed 15,137,650 long tons of iron ore, a greater amount than was produced by the entire country in 1889. This shows the unprecedented increase in thirteen years of eighteen times the amount contributed in 1889, viz, 864,508 long tons, when Minnesota occupied fifth position, while in the previous census year, 1880, no iron ore was mined in the state, the first production being in the year 1884. Since the year last mentioned the state has shown a phenomenal and practically an uninterrupted advance in the yearly output. The ore is obtained from the Vermilion and Mesabi ranges, that secured from the former being a hard specular or red hematite ore, while in the latter the red and brown hematites are much softer and in many localities quite finely comminuted. No true limonite ore is shipped from Minnesota, but the degree of hydration of some of the red hematites and the prevailing color encouraged the trade recognition of part of the state's product as brown hematite.

A comparison of the production and value of Minnesota iron ores at the last two census years is as follows:

Production and value of Minnesota iron ore: 1889 and 1902.

YEAR.	Quantity (long tons).	Value.
1889	864,508	$2,478,041
1902	15,137,650	23,969,227

Michigan.—In the year 1880 the amount of iron ore mined in Michigan was 1,640,814 long tons, giving the state second rank, Pennsylvania being first. The output increased in 1889 to 5,856,169 long tons, Michigan ranking first and continuing to hold that position until 1901. In 1902 the production was 11,135,215 long tons, nearly double that at the previous census. The greater portion of this ore was of high grade, although in late years some siliceous ores comparatively low in iron content and also low in phosphorus have been won for use as a mixture in the furnaces with richer ores low in silica. The three ranges from which this ore was mined, the Marquette, Menominee, and Gogebic ranges, are all located closer to shipping ports and to the principal pig iron manufacturing centers than the Minnesota ranges, and the ores therefore command a higher relative value at the mine than those of Minnesota, as will be seen from the following statement:

Production and value of Michigan iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	1,640,814	$6,034,648
1889	5,856,169	15,800,521
1902	11,135,215	26,695,800

Alabama.—In 1880 Alabama was a comparatively unimportant iron ore producer, the quantity obtained being 171,139 long tons, giving the state seventh position. The extensive deposits of fossil ores, particularly in the Birmingham district, located close to supplies of fuel and flux, were, however, the foundation of an important pig iron industry, and the amount of ore mined increased in 1889 to 1,570,319 long tons, which was more than doubled in the year 1902, when 3,574,474 long tons were won, as shown in the statement below. These ores, however, are not of so high a grade, nor are their values so great, as those of the Lake Superior district. In addition to the red hematite ores referred to, important deposits of brown hematite have been developed, and this class of mineral represents about one-third of the iron ore supply of the state. Some exploitation has also been carried on for the purpose of utilizing magnetites which occur in apparently moderate quantities.

Production and value of Alabama iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	171,139	$201,805
1889	1,570,319	1,511,611
1902	3,574,474	3,936,812

Virginia and West Virginia.—The iron industry in Virginia was established early in the seventeenth century, but as charcoal was the fuel used in the old furnaces, the amount of ore consumed, which was usually mined within convenient reach of the furnaces, was small. The production for 1880 in Virginia and West Virginia was 217,448 long tons. The output in 1889 was 511,255 long tons, and in 1902, 987,958 long tons. The iron ore supply of the Virginias has been supplemented in late years by the importation of iron ores from the Lake Superior region. Most of the iron ores now obtained in the Virginias are of the brown hematite variety, but some red hematites and magnetites are also mined. The production and value for the last three census years are given as follows:

Production and value of Virginia and West Virginia iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	217,448	$590,943
1889	511,255	835,290
1902	987,958	1,667,456

Tennessee.—Tennessee occupied tenth position as a producer of iron ore in 1880, eighth in 1889, and fifth in 1902, its output consisting of brown and red hematites, the amounts and values being as follows:

Production and value of Tennessee iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	98,272	$147,181
1889	473,294	606,156
1902	874,542	1,123,527

Pennsylvania.—Pennsylvania, which produced practically half of the total pig iron manufactured in the United States in 1902, might be supposed to be the largest iron ore producing state, and prior to improved transportation facilities this was the case. In the year 1880 it occupied first position, with a total of 1,951,496 long tons, declining to third in 1889, the output being 1,560,234 long tons, and to sixth place in 1902, produc-

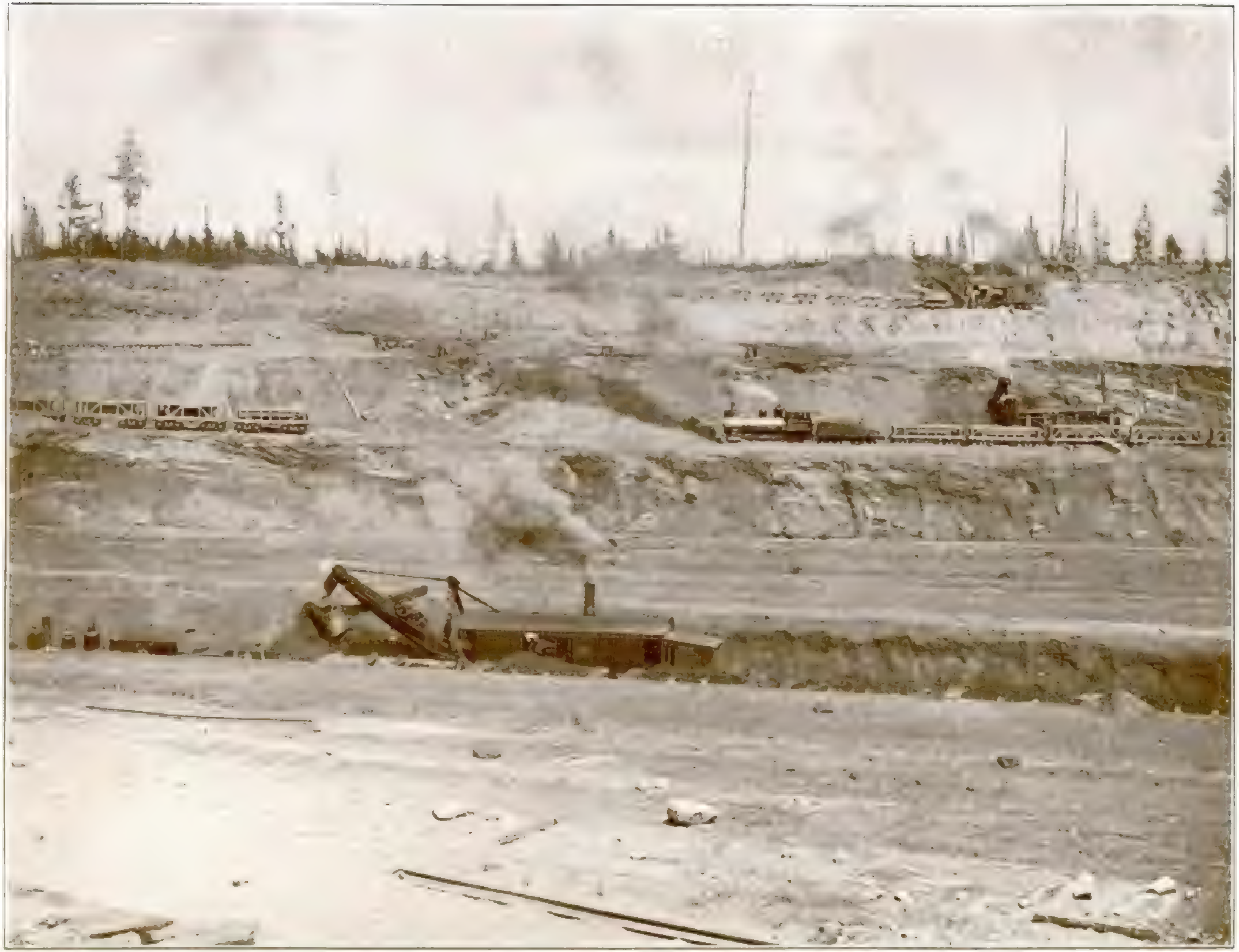

PLATE V.—MOUNT IRON MINE. MESABI RANGE, LOOKING EAST ACROSS PIT, SHOWING TWO STRIPPING AND THREE ORE LEVELS.

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ing only 822,932 long tons, due to the use by Pennsylvania furnaces of rich ores from other sections of the country. Magnetites predominated, brown hematite being second and red hematite least in importance. A statement of the quantity and value at each of the last three census years follows:

Production and value of Pennsylvania iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	1,951,496	$5,517,079
1889	1,560,234	3,063,534
1902	822,932	1,225,453

Wisconsin.—The bulk of the iron ore obtained in Wisconsin is secured from the Gogebic and Menominee ranges, which extend from the state of Michigan into Wisconsin. Most of the ore is red hematite, a small proportion being brown hematite. This state contributed 37,000 long tons of iron ore in 1880, 837,399 long tons in 1889, and 783,996 long tons in 1902, the quantities and values being as follows:

Production and value of Wisconsin iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value.
1880	37,000	$73,000
1889	837,399	1,840,908
1902	783,996	1,800,864

New York.—In earlier years large amounts of iron ore of all four classes were obtained from various deposits in New York, the total for 1880 being 1,126,899 long tons, giving the state third position. The output had risen in the year 1889 to 1,247,537 long tons, but in 1902 there was a decline to 555,321 long tons. The bulk of New York ores mined are magnetites, but some red and brown hematites are found. A statement for the last three census years follows:

Production and value of New York iron ore: 1880 to 1902.

YEAR.	Quantity (long tons).	Value
1880	1,126,899	$3,654,572
1889	1,247,537	3,100,216
1902	555,321	1,362,967

Other states and territories.—None of the other states or territories contributed over one-half million tons in 1902, and they will not, therefore, be considered individually. In the following table the production of these remaining states and territories in 1902, 1889, and 1880, is given, together with the total value of the iron ore mined:

TABLE 10.—*Quantity and value of iron ore, by states and territories: 1880 to 1902.*

STATE OR TERRITORY.	1902		1889		1880	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Colorado	[1]306,572	$1,084,424	109,136	$487,433		
Connecticut, Maine, and Massachusetts	[2]20,093	81,374	88,251	265,901	92,549	$382,929
Delaware and Maryland	[3]24,367	46,911	29,380	68,240	127,102	428,244
Georgia and North Carolina	264,890	505,488	258,145	334,025	84,594	118,967
Idaho and Montana	[4]3,090	19,642	24,072	158,974		
Kentucky	71,006	86,169	77,487	185,559	57,865	165,905
Missouri	66,308	106,879	265,718	561,041	344,919	1,674,875
New Jersey	441,879	1,228,664	415,510	1,341,513	676,225	2,910,442
New Mexico and Utah	[5]358,944	456,674	36,050	70,956		
Ohio	22,657	41,976	254,294	532,725	488,753	1,209,530
Oregon and Washington			26,283	39,231	[6]6,225	4,669
Texas	6,516	6,434	13,000	19,750	3,214	8,100

[1] Includes 13,275 tons of manganiferous iron ore, valued at $52,371.
[2] Includes Vermont, no production from Maine.
[3] Maryland only.
[4] Montana only.
[5] Also Wyoming.
[6] Oregon only.

The predominating ores obtained from these states are brown hematite from New England, Delaware, Maryland, Georgia, Colorado, Oregon, Washington, and Texas; magnetites from New Jersey, North Carolina, and New Mexico; red hematites from Missouri and Wyoming; and carbonates from Ohio.

Table 11 shows in a general way the status of the iron ore industry in the United States by important districts.

TABLE 11.—*Summary, by districts: 1902.*

	Lake Superior district.[1]	Southern district.[2]	New York, New Jersey, and Pennsylvania	Virginia and West Virginia.	Rocky Mountain district.[3]
Number of mines	151	100	77	63	43
Number of operators	79	57	64	26	28
Salaried officials, clerks, etc.:					
Number	1,358	393	291	260	50
Salaries	$1,298,380	$302,337	$211,889	$175,184	$95,304
Wage-earners:					
Average number	23,999	6,851	3,765	2,699	713
Wages	$15,308,242	$2,771,647	$1,641,532	$802,254	$617,207
Contract work	$398,376	$500	$11,928	$6,730	$3,940
Miscellaneous expenses	$7,385,070	$276,484	$221,077	$121,356	$160,061
Cost of supplies and materials	$6,725,009	$861,758	$809,603	$201,726	$272,425
Product:					
Quantity, long tons	26,977,404	4,779,570	1,820,132	987,958	668,606
Value	$52,422,685	$5,513,056	$3,817,104	$1,667,156	$1,559,740
Mechanical power:					
Horsepower	70,004	15,916	17,233	4,786	1,095

[1] Includes Michigan, Minnesota, and part of Wisconsin.
[2] Includes Alabama, Georgia, and Tennessee.
[3] Includes Colorado, Montana, New Mexico, Utah, and Wyoming.

No attempt was made to include in Table 11 the statistics for the entire country, as such data are presented in other tables, but the states of Michigan, Minnesota, and Wisconsin are grouped in the Lake Superior region, while the southern district includes the iron ore mines of Alabama, Georgia, and Tennessee. Other important groups of states, such as New York and New Jersey combined with Pennsylvania, and Virginia combined with West Virginia, are also shown, and the Rocky Mountain region is presented as a whole to indicate the extent of iron ore production in that section of the country. The comparisons suggested by the table will be understood as covering the districts generally, and not as applicable to the individual mines.

It will be noted that 151 mines in the Lake Superior region produced 26,977,404 long tons, equivalent to 178,658 long tons per mine, while in the Southern district 100 mines produced 4,779,570 long tons, an average of 47,796 long tons per mine, mainly attributable to the difference in the character of the deposits of the two regions. The Lake Superior ores occur in large beds or lenses, making the local development extensive, and encouraging the introduction of labor-saving appliances. The high grade of ore mined, as compared with that in other parts of the country, is also responsible in part for the extensive development. In the Southern district the ore deposits are either in stratified beds or in pockets, and the local developments while important are not so large, nor is the ore as rich as in the Lake Superior region; therefore, the application of labor-saving appliances is not justified to the extent it is in the Lake Superior district.

Imports.—While enormous quantities of rich iron ores are produced in the United States, large amounts of iron ores are imported, principally from Cuba (where all of the mines are operated by American capital), and used in blast furnaces located in the eastern portion of the United States. Small quantities are also brought in to supply the charcoal furnace located at Port Townsend, Wash., and for other uses than smelting.

The following table shows the quantity and value of the iron ore imported during the years 1889 to 1902:

TABLE 12.—*Quantity and value of iron ore imported: 1889 to 1902.*

YEAR.	Quantity (long tons).	Value.	YEAR.	Quantity (long tons).	Value.
1889	853,573	$1,852,392	1896	682,806	$1,006,917
1890	1,246,830	2,854,118	1897	489,970	678,912
1891	912,864	2,456,521	1898	187,208	255,548
1892	806,585	1,796,644	1899	674,082	1,082,847
1893	526,951	906,687	1900	897,831	1,303,196
1894	167,307	267,241	1901	966,950	1,659,273
1895	524,153	796,207	1902	1,165,470	2,568,077

The values given are those placed on the iron ore at the point of shipment and do not include any allowance for freight or import duty.

Previous to 1892 Spain ranked first as a contributor, supplying in 1890 over half a million tons, the ores coming from the Bilbao district, in the northern portion of the country, or from mines located near the Mediterranean sea, in southern Spain. In 1892, however, Cuba took first rank, which position it still holds. In the earlier years Algeria and Italy were also important contributors, but lately the amount received from these countries has been small, and in some years none has been imported.

In 1889 and 1890 Greece forwarded a comparatively small amount of iron ore, some of which contained a small percentage of manganese. Newfoundland and Labrador contributed ore in 1889, 1890, and 1896.

In the year 1902 the imports of iron ore, 1,165,470 long tons, were the largest since 1890, when 1,246,830 long tons were brought to this country. Cuba was the principal contributor in 1902, supplying 696,375 long tons; the provinces of Quebec and Ontario, Canada, sent 203,824 tons; Spain, 153,527 tons; and Newfoundland and Labrador (principally Newfoundland), 81,920 tons. Smaller amounts were imported from Algeria, Belgium, British Columbia, France, Germany, and Great Britain.

Table 14 is a detailed summary of the statistics for active mines, by states and territories. Where one or two operations only were active in a state, the statistics have been combined in order not to disclose individual operations, and are presented under the head "all other states and territories." This table, in connection with Table 9, presents a synopsis of the entire iron ore industry of the United States.

DESCRIPTIVE.

The phenomenal record made in producing pig iron in the United States is illustrated by the following statement from the annual statistical report of the American Iron and Steel Association. This shows the growth in the manufacture of pig iron in the past nine years, until in the year 1902 the maximum production approximated 18,000,000 tons.

Production of pig iron: 1894 to 1902.

YEAR.	Long tons.	YEAR.	Long tons.
1894	6,657,388	1899	13,620,703
1895	9,446,308	1900	13,789,242
1896	8,623,127	1901	15,878,354
1897	9,652,680	1902	17,821,307
1898	11,773,934		

This record naturally invites attention to the materials entering into the manufacture of pig metal, the character of these materials, and the sources from which they are obtained. Fuels, iron ores, and fluxes, components of commercial pig iron, in passing through blast furnaces, produce either pig iron in merchantable form or liquid metal, to be carried to Bessemer converters or open-hearth furnaces. In 1902 an effort was made on behalf of the Canadian government in equating bonuses to iron industries, to discriminate against liquid metal being classed as pig iron, but the contention was not sustained, and commercially the entire product of blast furnaces smelting iron ore is considered and reported for statistical purposes as pig iron.

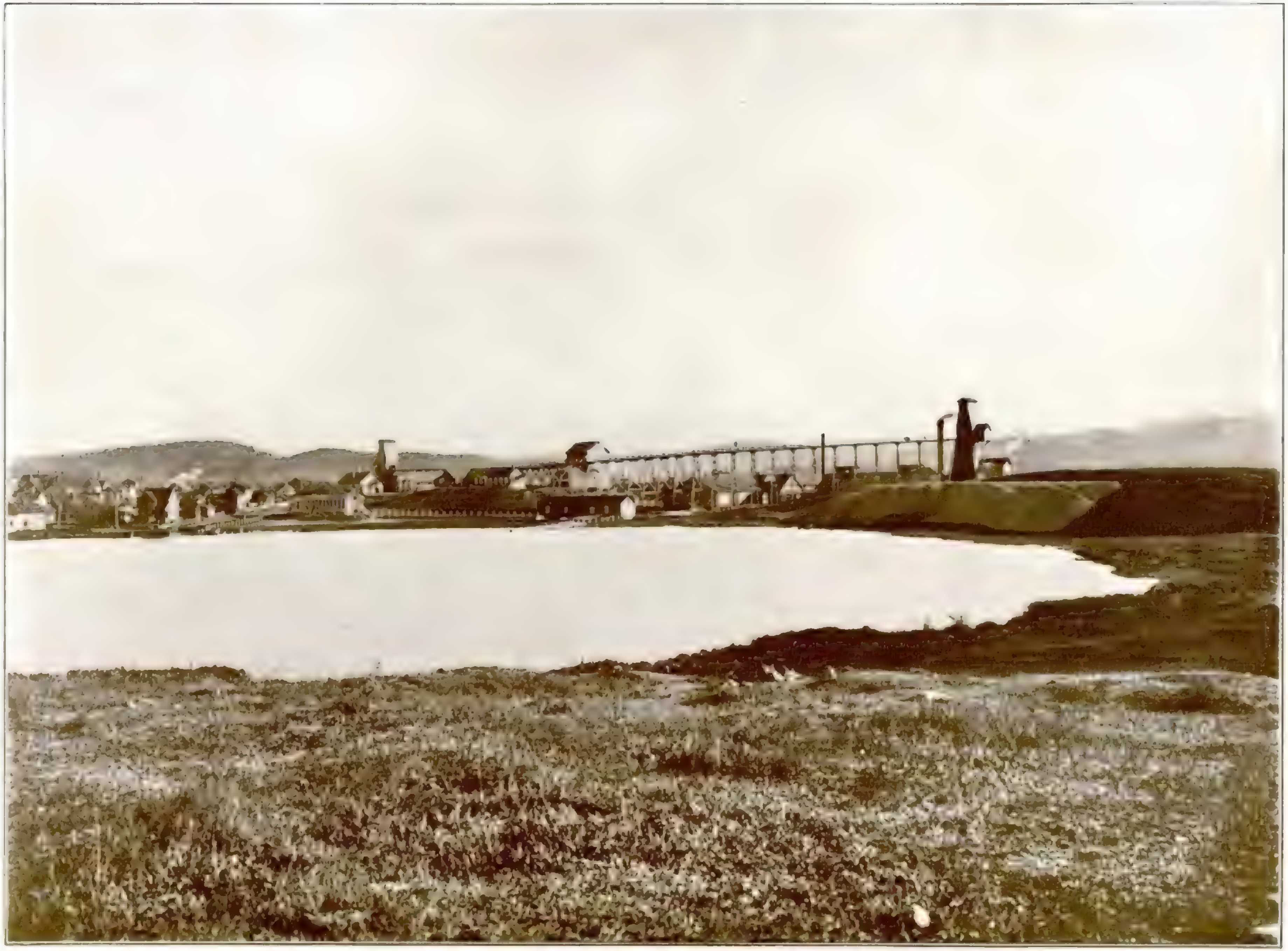

PLATE VI.—GROUP OF MINE BUILDINGS AND DWELLINGS, CLIFFS SHAFT MINE, LAKE BANCROFT, MICHIGAN.

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For the production of the quantity of pig metal credited to the United States in the year 1902 there were required about 30,000,000 tons of bituminous coal (the larger portion of which was converted into coke) and about one million and a half tons of anthracite coal. In addition to mineral fuel probably 350,000 tons, or 38,000,000 bushels of charcoal were consumed in blast furnaces. About 33,000,000 tons of iron ore were fed to the furnaces, and the flux necessary to carry away the impurities of the ores is estimated at about eight and a half million tons. Therefore, to supply the blast furnaces of the United States in 1902, which produced nearly 18,000,000 tons of pig iron, there were required about 73,000,000 tons of raw materials.

In the manufacture of pig iron a considerable quantity of rolling mill cinder, roll scale, etc., is produced which is also employed practically as ore. Some "blue billy" or "purple ore," resulting from the calcination of pyrites and the residuum from roasting ferriferous and manganiferous zinc ores, are also utilized. The total amount of iron ore and of materials used as ore made available in the United States in 1902 may be approximated as follows:

	Tons.
Domestic iron ores	35,567,410
Foreign iron ores	1,165,470
Roll scale, mill cinder, blue billy, etc	1,900,000
Total	38,632,880

Some iron ore is employed for other purposes than for the manufacture of pig iron. It forms an important part of the charge of many open-hearth steel furnaces, and is used also for fix in puddling and other furnaces, for flux in silver smelting, and in making metallic paints. After making allowance for the other materials that are used as ore and deducting the quantity of ore which is applied to purposes other than iron production, the actual quantity of iron ore and materials used as ore entering into the manufacture of pig iron in 1902 is found to be, approximately, 33,000,000 long tons.

The active demand for iron ore to maintain in operation the blast furnaces of the United States, and the expectation that this demand would continue, was responsible to a great extent for the phenomenally large output of the iron ore mines in the year 1902. Large stocks of ore accumulated at or near blast furnace plants aided in swelling the total iron ore supply to figures never before reached and which may not be exceeded in the near future.

CLASSIFICATION OF IRON ORE.

Iron ore may be considered in four general commercial classes, as follows:

(1) Red hematite, including all anhydrous hematites, known by various names, such as red hematite, specular, micaceous, fossil or slate iron ore, martite, blue hematite, etc.

(2) Brown hematite, including the varieties of hydrated sesquioxide of iron, recognized as limonite, goethite, turgite, bog ores, pipe ores, etc.

(3) Magnetite, an ore in which the iron occurs as magnetic oxide and which includes some martite, mined with the magnetite. Martite is a red hematite ore which preserves to a varying extent the crystalline form of magnetite, but which is nonmagnetic or nearly so.

(4) Carbonates comprise those ores which contain a considerable amount of carbonic acid, such as spathic ore, blackband, siderite, clay ironstone, etc.

This classification is to be considered as general, the ores having various local or trade names. Thus the prevailing color or general physical appearance is used to indicate an ore, as blue, black, red, or brown, micaceous or glistening hematite. The term "specular," although more properly applied to a glistening ore, is by custom given to many dull red hematites. Other hematites receive designations according to their topographical or geographical occurrence, as "fossil," "mountain," or "valley" ore, or to the structure, as "flaxseed" ore, "slate" ore, etc. In the brown hematite class "limonite," "turgite," etc., are mineralogical terms referring to the degree of hydration, but the physical structure and appearance of some of the ores are described by the term "lump" ore, "pipe" ore, "botryoidal" ore, "needle" ore, etc. The beneficiating of brown hematites has given rise to the terms "wash" ore, "sand" ore, etc. The carbonate ores are known as spathic ore, limestone ore, blackband ore, kidney ore, etc.

The association of other substances with iron also furnishes names to certain ores, such as pyrite, pyrrhotite, ilmenite, chromite, etc., but in this discussion it is not essential that either the chemical, mineralogical, or physical features of the various ores should be considered in detail.

The early iron industry of the United States was based largely upon bog ores, limonites, or other forms of brown hematites, obtained at points convenient to the Atlantic seaboard. Magnetites also were employed at first by means of a direct process whereby, in Catalan forges, the ores were reduced and the resulting metal forged into blooms or billets without passing through the casting process; subsequently magnetites as well as hematites were smelted in blast furnaces. But the later development of the iron industry and present great importance are due largely to the use of red hematite ore.

The brown hematites and red hematites are of the same chemical composition in so far as iron oxide is the basis of the ore, the primary differences being structural and the lower percentages of combined and hygroscopic water in the red hematites. Red hematite, if free from other impurities, will yield 70 per cent of iron, and pure brown hematite, if thoroughly dried out and calcined to eliminate all water, will also yield the same proportion of iron. But if the ores are merely dried to drive off the moisture, which differs under varying conditions, the amount of metallic iron possible in a pure red hematite is about 70 per cent, and in a pure brown hematite 60 per cent. However, iron ores seldom occur practically pure, the amounts of silica, alumina, lime, magnesia, and of such elements as manganese, chromium, sulphur, phosphorus, titanium, etc., reducing the actual percentage of metallic iron obtainable from ores.

Magnetic ores are capable of yielding in the pure state more metal than any other ores, and pure magnetite would show 72.48 per cent of metallic iron, but magnetites, like the hematites, are subject to deterioration from other elements which are present.

The fourth form of iron ore is the carbonate or spathic, in which the oxide of iron is associated with carbonic acid and generally with lime. If this carbonic acid is driven off by heat carbonate ores become practically brown hematites, but in the natural state the purest carbonate would not yield over 46.7 per cent of iron. Considerable of the early iron industry, particularly in western Pennsylvania, eastern and southern Ohio, Kentucky, and Maryland, and also to a certain extent in eastern New York, was based upon the use of carbonate ores, but because of the facts that these ores in their natural state are "lean," that they usually occur in veins that must be worked underground, often deteriorating as workings are extended, and that the ore must be roasted, the quantity of carbonate iron ores employed has been greatly reduced, until in the year 1902 only 27,642 tons were used.

In late years the quantity of magnetic iron ores utilized annually in producing pig iron has increased but slightly, although some remarkable deposits of these ores are available. But magnetites are not as readily reduced as the hematites, are often dense and hard, are liable to have an excess of sulphur, phosphorus, or titanium, or are so closely associated with the gangue matter as to make them lean, demanding that roasting or some method of concentration, either by hydraulic or magnetic separators, should be employed.

Brown hematites occur mostly in pockets or lenses, but are occasionally found in strata, often associated closely with limestone, and also more or less intimately mixed with clays and siliceous matter. Consequently, many brown hematites require washing to separate the clay and sand, and in some cases this washed ore is subsequently roasted to drive off the excess of moisture.

All methods of beneficiating ores, such as roasting, washing, and separating, add to the expense of production, and it is therefore not surprising that red hematites, which seldom require preliminary treatment, have met with general favor. This preference can also be explained by the fact that the ores are usually readily reducible, and most of those mined yield satisfactory percentages of iron. Another feature of material advantage is that many red hematites occur in large and well-defined lenses or bodies, permitting the exploiting of the deposits on a large scale by utilizing labor-saving appliances. The use of such appliances may extend from the winning of the ore at the mine to its delivery at the blast furnaces. Thus a large proportion of the red hematite ore from the Lake Superior region is never touched by manual labor. That which is obtained from open cut workings is in many cases dug by steam shovels which load the ore into standard railroad cars. In some underground mines manual labor is confined practically to directing the ore into "mills" and chutes, which discharge into mine cars, these cars being elevated and automatically dumped into bins from which standard railroad cars are loaded. In other underground operations it is necessary to shovel the ore by hand into mine cars, but thereafter labor-saving appliances are available.

Most of the ore mined in the Lake Superior region is carried in standard railroad dump cars to shipping docks, where it is dropped into bins, from which chutes convey it into the holds of vessels brought to the side of the docks. These vessels are unloaded by mechanical appliances, which deliver the ore either onto stock piles or into standard railroad cars, which carry it to the blast furnaces. At the blast furnace plants there are equally satisfactory mechanical appliances, such as car dumpers, which empty a 100,000-pound car by reversing it, or traveling bridges, fitted with large buckets, which transfer to bins or to stock piles the ore dumped from the cars. These devices are so perfected that only a small amount of ore is touched by hand from the time it leaves its native bed until it passes into the blast furnace, and while they are most in evidence in the Lake Superior region they are in use in connection with important iron ore mines in other portions of the country.

DISTRIBUTION OF ORE DEPOSITS.

The distribution of iron ore throughout the United States is general; there is no state in which iron ores of some kind are not found in considerable quantities, but all are not available for use.

In some cases the ores are too lean, that is, carry too small a percentage of iron; in others deleterious elements, such as phosphorus, sulphur, silica, and titanium, are in excess. Some deposits are too far from desirable fuel, or too inconvenient to blast furnaces, to make their immediate utilization practicable; others are in small bodies or veins, or are scattered over too large areas to make their exploitation profitable. It is probable that some of the undeveloped deposits may be exploited in

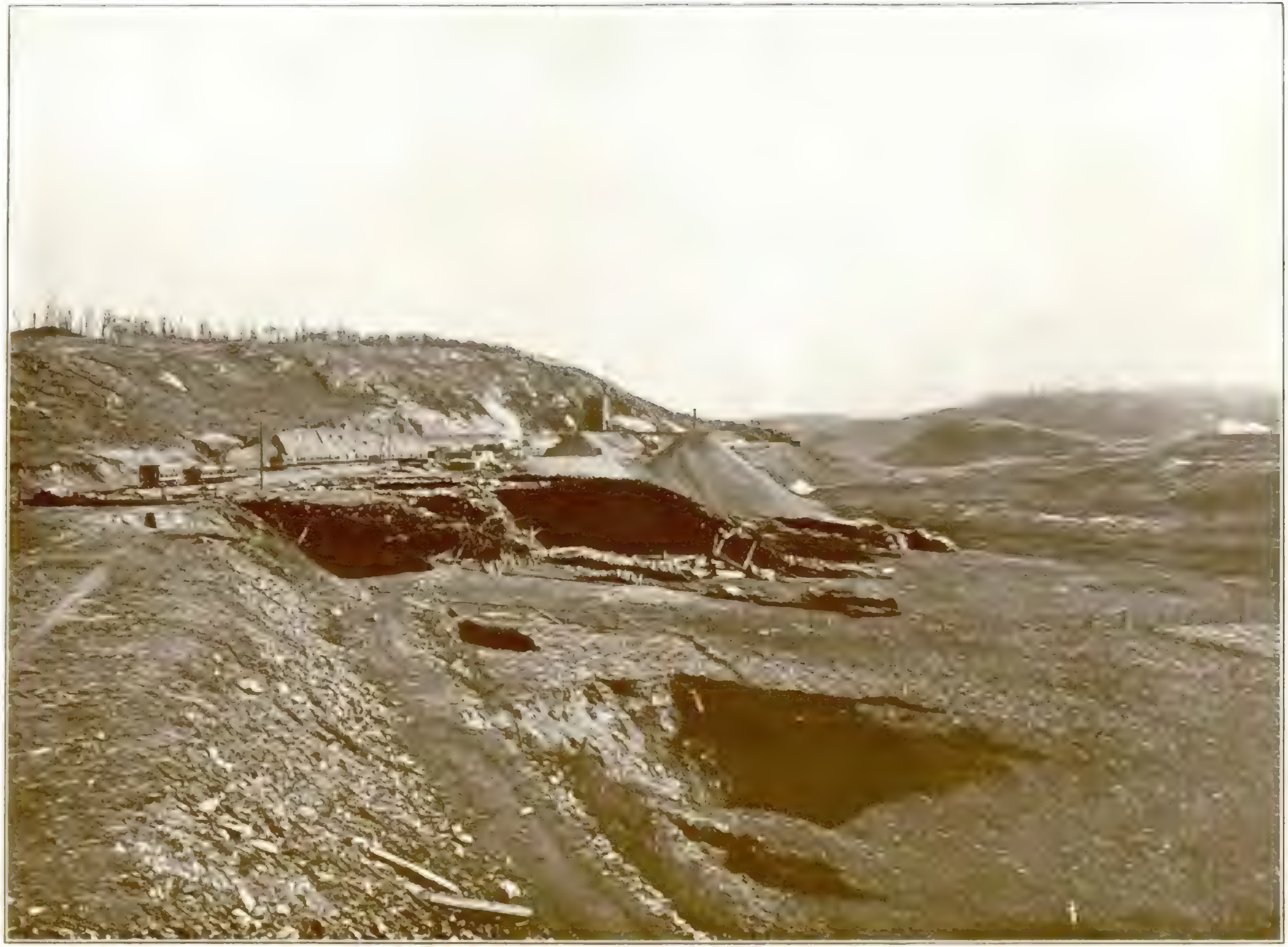

PLATE VII.—CLEVELAND LAKE MINE, MARQUETTE RANGE, MICHIGAN, LOOKING EAST.

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the near future as the development of newer sections of the country makes fresh demands for iron, or as the extension of railroad facilities and water transportation brings the ores and fuel into convenient association. Improvements in smelting and fluxing ores, which are now considered undesirable because of the presence of some of the elements mentioned above, may also make the production of satisfactory metal from these ores a commercial possibility. While the manager of a smelting plant can obtain ores high in iron, or those which need no beneficiating treatment, at prices which permit him to produce metal at a satisfactory profit, he can not be expected to consider favorably supplying the blast furnaces under his direction with inferior raw material. But the rapid increase in the output of the blast furnaces to meet the growing demands of a developing country may in the near future encourage the utilization of ores which are now considered undesirable.

While the statistical data is reported by states, except in such cases as would disclose individual statistics, a presentation of the industry according to prominent districts is offered as of interest, for the lines dividing states are lost in anything affecting the industry of the nation. The statistics for these districts are presented in summarized form in Table 11.

The Lake Superior region.—The greatest development of iron ore deposits in the world is in the Lake Superior region, which in 1902 produced 26,977,404 long tons, or 76 per cent of the total output for the United States. No other section of the United States, and no other district in the world, has shown such marvelous development or produced so much iron ore as the region embracing parts of northern Michigan and Wisconsin and the eastern portion of Minnesota. Whether in the same extent of territory elsewhere there may or may not be larger deposits of iron ore of equally desirable composition can not be asserted, for it is by development that these great properties have become known and their reserves approximately determined. But to-day the Lake Superior region stands in a unique position by reason of the large quantity and generally superior character of iron ores won from the five ranges or subdistricts which it embraces. Some of these mines have been in operation for fifty years, a number of them for half that time, but the largest annual producers are later developments.

The initial shipment of iron ore from the Lake Superior region is credited to the year 1856; the development has advanced almost constantly, and about two-thirds of the total product since 1856 has been taken from its mines in the last ten years.

The production of iron ore in the Lake Superior region in the past decade and the quantity previously shipped are as follows:

Production of Lake Superior iron ore, 1893 to 1902, with previous shipments.

YEAR	Long tons.
1893	6,594,620
1894	7,682,548
1895	10,268,978
1896	10,566,350
1897	12,205,522
1898	13,779,308
1899	17,802,955
1900	20,564,228
1901	21,445,903
1902	26,977,404
Total for 10 years	147,887,835
Previously shipped	73,440,647
Aggregate	221,328,482

The mines of this region are located at an elevation of from 1,000 to 1,500 feet above Lake Superior, the distance from the lake varying from a few to a hundred miles. The output finds cheap transportation for the rail haul to the lakes, has grades favorable to the traffic, and on the lake shores expensive and well-equipped docks have been constructed at seven different ports, where the ore coming in train loads is received into bins, and delivered from the bins by gravity into the holds of vessels. The vessels take the ore from the shipping docks and carry it through two or more of the Great Lakes to receiving docks where equal facilities for unloading by mechanical appliances have been provided. In this way enormous quantities of ore are handled cheaply and expeditiously.

The Lake Superior region is also unique in that its location is such that ore can be delivered at furnaces, in a populous section of the country, and there meet a cheap fuel supply; in other words, its market facilities are unexcelled. It has been this which has chiefly encouraged the phenomenal development.

The quantities of iron ore obtained from the five ranges embraced in the Lake Superior region, taking these in the order of their initial shipment, are as follows:

The Marquette range, in the northern peninsula of Michigan, has contributed since 1854 a total of 66,915,217 long tons, or 30 per cent of the entire production of the Lake Superior region.

The Menominee range, south of the Marquette range and extending from the northern peninsula of Michigan across into northern Wisconsin, has shipped, since 1877, 42,406,228 long tons, or 19 per cent of the entire production.

The Gogebic range, west of the Menominee and Marquette, partly in the northern peninsula of Michigan and partly in Wisconsin, has supplied, since 1884, 38,288,761 long tons, or 17 per cent of the entire production.

The Vermilion range, in the eastern portion of the state of Minnesota, has, since 1884, sent forward 19,074,424 long tons, or 9 per cent of the entire production.

The Mesabi range, in Minnesota, south of the Vermilion range, in the brief interval since its opening in 1892, has furnished 54,641,532 tons, or 25 per cent of the entire production of the region.

The total production of these five ranges since their opening is 221,326,162 tons, and adding 2,320 tons not credited to any particular range, the grand total for the Lake Superior region is 221,328,482 tons. This far exceeds the quantity of iron ore won from any other mining district in the world, and the amount obtained in the year 1902 from these five ranges, which represents their maximum production, is in excess of the entire production in one year of any foreign country. The quantity of ore won from the state of Minnesota in 1902 has only been exceeded by the yearly production of Great Britain in thirteen years and of Germany in six years. None of the other foreign countries has as yet reached a total approximating this state's 1902 output.

The Vermilion range, in Minnesota, was opened in the year 1884. The ore which is there produced is a hard specular, high in iron, and usually of Bessemer grade. This range is the farthest removed from the principal pig iron producing centers, and the high esteem in which the ore is held is shown by the fact that much of it traverses a distance of over 1,000 miles to points of consumption. The two principal producing mines in this range are known as the Pioneer and the Chandler. Plate I is a surface view of these mines, showing the shafts and various buildings connected with the mining operations, the large open cut, and the extent to which timber has been denuded for mine supports and fuel.

Plate II shows the Auburn mine, on the Mesabi range, in Minnesota. The ore in this deposit is won by the "milling" system, in which the surface earth is removed and the ore drawn through "raises" into drifts located some distance below the top of the ore, making in this way large sinks or craters. This system requires that the cover be stripped, and is especially adapted to shallow deposits of soft ore. The plate gives an excellent view of the crater which is formed by the mining. A steam shovel is at work loading ore cars, which are taken through the tunnel shown to the shaft, through which it is elevated to the surface.

Plate III is a view of the No. 2 pit of the Adams mine, where red hematite is obtained; it is located at Eveleth, Minn. The incline plane is shown bottomed in ore, while in the left of the illustration are seen the tunnels which are run back in the ore. Operations have been carried on at this mine both in open pits and underground.

In some of the newer mines modern apparatus has been installed. Plate IV shows a view of a steel shaft frame at the Adams mine. It is provided with hoppers in which to receive ore from skip cars, and was one of the first of this class to be erected in the country.

Plate V, a view on the Mesabi range, in Minnesota, shows large deposits of ore. These are usually of a comparatively soft character, lying in nearly horizontal strata and with covering of such slight depth that they can be easily stripped. The ore is won by means of steam shovels which place it directly on iron ore cars, in which it is hauled to the docks. In this way immense quantities of ore are cheaply and easily obtained. It is owing principally to these mines that Minnesota shows a larger production per employee than any of the other states.

The view presented herewith shows the Mountain Iron mine, located at Mountain Iron, Minn., in which three steam shovels are shown, one being at work, as seen at the top of the picture, stripping the ore, while in the foreground another shovel is engaged in loading the cars, and on the right-hand side a third shovel is at work.

Around some of the more important mines in the Lake Superior region towns have sprung up, which are dependent entirely upon the iron ore industry. Plate VI shows a group of mine buildings, crusher house, A and B shafts, and some of the dwelling houses located at the Cliffs Shaft mine on Lake Bancroft, Mich., and gives a good idea of the general surface appearance of a well conducted Lake Superior iron ore mine.

The earliest mining in the Lake Superior district was on the Marquette range and one of the oldest operations is the Cleveland mine, which has been supplying ore constantly for a period of over fifty years. Plate VII shows a general view of the Cleveland Lake mine of the Cleveland Cliffs Company, looking from the east. The shaft houses, ore piles, and dumps are shown, together with the ore cars. In the foreground are immense piles of lumber. The lake bed, drained for the purpose of extending mining operations, may also be seen.

Most of the iron ore won in Michigan is taken from underground mines; the only views obtainable of these are such as are taken by flash light. Plate VIII illustrates the Cliffs Shaft mine, one of the more prominent on the Marquette range in Michigan. A mine car running along a track placed at the bottom of the drift is loaded with ore which has been broken down by means of explosives. A power drill in operation is shown in the right of the picture.

Plate IX is a view of part of the open cut of the Salisbury red hematite mine, on the Marquette range, in Michigan.

In the summer of 1903 the Lake Superior Iron Mining Company, a pioneer of the region, celebrated the fiftieth year of its activity, and the following statement,

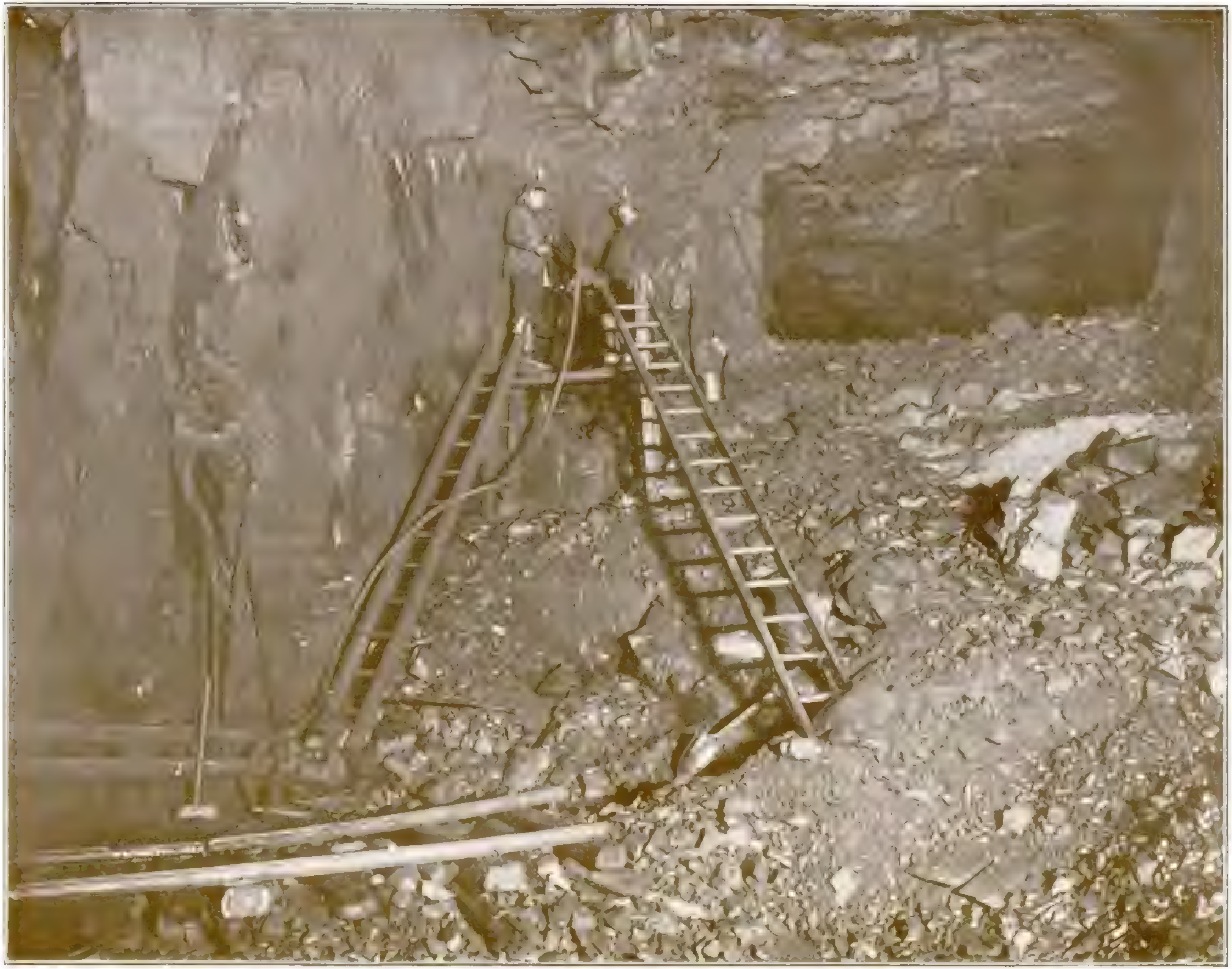

PLATE VIII.—CLIFFS SHAFT MINE, MARQUETTE RANGE, MICHIGAN.

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which embraces the salient points of a contribution for the occasion by the author of this report, emphasizes the development referred to:

> Neither the records of the production of the Lake Superior region nor the annual reports of the American Iron and Steel Association go back beyond 1854; therefore no data earlier than this will be exact.
>
> In 1854 there was one mine reported as operating in the Marquette range, the shipments amounting to 3,000 tons. In 1902 the shipments of the Marquette range were 3,868,025 tons, the lake shipments from all ranges in that year reaching a total of 27,039,169 tons.
>
> The production or consumption of iron ore in the United States in 1854 can only be estimated from the quantity of pig iron made. According to the census statistics of 1850 there would have been in the neighborhood of 1,500,000 tons of iron ore consumed during that year, for there was made in the country 563,775 tons of pig iron. In 1854, according to the reports of the American Iron and Steel Association, 736,218 net tons, equivalent to 657,337 gross tons, of pig iron required about 1,750,000 tons of iron ore, whereas in 1902 the country produced 17,821,307 gross tons of pig iron, and the domestic output of all the iron ore mines in the country for 1902 was 35,567,410 long tons.
>
> At least 137 producing mines are now active in the Lake Superior region, a number having exceeded annual outputs of 1,000,000 tons, and one mine has approximated 2,000,000 tons in a year. The estimated iron ore production of the country in 1854 approximated 1,750,000 tons, based upon the reported pig iron production, and the yield of ores did not exceed an average of 40 per cent of metallic iron. Therefore, it is doubtful if in 1854 the United States produced as much iron ore as the Fayal mine in Minnesota did in 1902, which in that year shipped 1,919,172 tons. Considered on the basis of metallic contents, however, this output of the Fayal mine probably produced as much pig iron as was made in the United States in any year up to 1866.

In order to indicate the chemical composition of the iron ores obtained from the Lake Superior district the following statements have been prepared. The first shows what may be considered as representative compositions of standard ores of each of the ranges; and in the second the analyses are for the lower grade ores, which are employed largely because of high silica and low phosphorous contents. These analyses are of ores in their natural condition, and represent cargo lots. Determinations of ores obtained from individual mines in each of the ranges will vary from those given in the statements.

Typical analyses of Lake Superior iron ores.

CONTENT.	Marquette range (per cent).	Menominee range (per cent).	Gogebic range (per cent).	Vermilion range (per cent).	Mesabi range (per cent).
Iron	56.5	55.2423	60.308	61.86	56.0996
Phosphorus	0.0858	0.0594	0.0538	0.0373	0.0365
Silica	4.584	6.7693	3.5961	4.2545	3.4867
Sulphur	0.0049				
Moisture	11.85	6.525	10.828	4.5649	12.3158

Analyses of siliceous ores.

CONTENT.	Marquette range (per cent).	Menominee range (per cent).	Vermilion range (per cent).
Iron	42.27	42.129	51.1938
Phosphorus	0.0356	0.0244	0.0498
Silica	35.894	34.141	22.3642
Sulphur	0.0099		
Moisture	1.23	2.2	3.21

Alabama-Tennessee, or Southern district.—Next to the Lake Superior district in order of present importance, basing such importance on the quantity of iron ore produced, is the district of which Birmingham, Ala., may be considered the business center, embracing northern Alabama, part of northern Georgia, and part of southern Tennessee. In 1902 Alabama supplied 3,574,474 tons, Georgia 330,554 tons, and Tennessee 874,542 tons, making a total for this district of 4,779,570 tons of iron ore. The bulk of the Alabama ores are red hematites, these ores being largely mined convenient to Birmingham. There is, however, a considerable quantity of brown hematite mined in Alabama and also in Georgia and Tennessee. A statement covering the classification of ores in these three states for the year 1902 may be summarized as follows:

Production of iron ores, Southern district, by states and varieties: 1902.

STATE.	Total (long tons).	Red hematite (long tons).	Brown hematite (long tons).
Southern district	4,779,570	3,054,090	1,725,480
Alabama	3,574,474	2,565,635	1,008,839
Georgia	330,554	117,812	212,742
Tennessee	874,542	370,643	503,899

Apparently the largest development of the hematite ores flanking the Allegheny mountains exists in Alabama, where the red hematite (known locally as Red mountain ores), obtained in large quantities close to deposits of coal suitable for the manufacture of coke, have encouraged the growth of the iron industry. The red hematites are locally recognized as soft and hard ores, the former, being at or near the surface, are partially decomposed; the latter are mined by underground workings and may be subdivided into siliceous ores, in which silica is present in quantity, and "limey" ores, in which the proportion of lime may be such as to make the ore approximately self-fluxing. Nearly parallel with the Red mountain deposits are important beds of brown hematite and limonite ore, occurring in isolated deposits, some of large extent. In fact, the exploited brown hematite deposits of this region are of greater average extent than those found in other portions of the country. Occasional deposits of magnetite are also found in the Alabama-Tennessee district, but few have been worked. Some carbonate ore has also been won and used in the manufacture of special irons.

Plate X illustrates the openings at one of the Red mountain mines near Birmingham. Plate XI is a view of a limonite bank near Tecumseh, Cherokee county, Ala.; the ore is broken down, loaded onto tram cars, as shown, and taken to washers, from which it goes to the railroad cars.

New York and New England.—Magnetite iron ores are produced chiefly in New York, New Jersey, and Pennsylvania, but some are won from North Carolina, Michigan, New Mexico, and Utah. The deposits of this class of mineral in New York state are phenomenally large, and so far as metallic contents are concerned, unusually rich; but many carry phosphorus, sulphur, or titanium in excess, some of the most extensive deposits having so much titanium that they have not been brought into commercial use. High phosphorous ores, however, have been and are mined to a large extent, and beneficiated by magnetic concentration. Some ores in the vicinity of Port Henry, N. Y., carry as high as 3 per cent of phosphorus, as apatite, mixed with the magnetic crystals, which, after the ore is comminuted, can be readily separated, either by magnetic separators or by jigs. Other ores of the Port Henry mines district are of Bessemer grade, and from one opening 30,000 tons of very high grade magnetic ore were obtained. This ore approached chemical purity, was of Bessemer grade as to phosphorus contents, and was practically a mass of well-defined octahedral crystalline forms, some an inch and a quarter on the face, many having practically perfect proportions. Still larger sized crystals have been found, but these were more or less imperfect, and masses of crystals affected by pressure had some faces flattened.

The localities which have been worked in the Lake Champlain district are the mines at Chateaugay, west of Plattsburg; the mines at Moriah, west of Port Henry; and those west of Crown Point. These deposits are at elevations of from 600 to 1,000 feet above the level of Lake Champlain, and while some explorations originally developed beds of considerable size by an open cut, most of the mining is now underground, and much of it at a depth of 500 feet or more. Some mines which have been exploited are adjacent to the shore of the lake, others are close to the Adirondack mountains, and some are on the western side of the range. Prominent among the titaniferous ore deposits are the Split Rock mine, on Lake Champlain, and the Adirondack Village mine, close to the main Adirondack range. These titaniferous ores were utilized in former years by the Catalan or direct process, in which the ore was converted into metal by charcoal in open hearths.

The Port Henry mines, located at Mineville, near Lake Champlain, in Essex county, have long been famous as a source of iron ore supply; it is claimed that the first ore was taken out in 1804. The ore is a dense magnetite, and Plate XII is a view of No. 21 mine of the Port Henry Iron Ore Company. It shows the large pillars of pure ore left to support the roof of the mine, the operations now being practically all underground. It is estimated that there are in the pillars of this mine and of the mines adjoining, belonging to Witherbee, Sherman & Co., at least 800,000 tons of ore. The deposit is very large, having a thickness in some places of 400 feet. The ore bodies are divided into two parts by a horse of rock, and at the lower depth diamond drillings have indicated the existence of two underlying veins of ore high in iron and phosphorus and low in silica. The ore which is sold in the market is high in iron, but also contains phosphorus in the form of apatite, making it all of non-Bessemer quality.

Other deposits of magnetite occur in the Hudson river district, the most pronounced exposures and veins being south of West Point on the Highlands east of the Hudson river, extending as far as Croton Falls, but some magnetite is also found west of the river, and this line of deposits can be traced from New York into New Jersey. The southern New York magnetites are, as a rule, lean, and contain either an excess of phosphorus or, more frequently, of sulphur. There has been considerable exploitation of these deposits, but outside of the Tilly Foster mine none has been a large producer, and all are inactive. The Tilly Foster appeared to be a large lens, which was worked first as an open bed, then the ore body was followed by shafting, the rooms being filled with concrete arches to permit the removal of pillars, and finally the working was restored to an open pit by the removal of 600,000 cubic yards of overlying rock. Large expenditures were also made on the Theall mine, near Brewster, which was worked by an extensive tunnel with stopes, shafts, and galleries. A concentrating plant was erected at this mine, but subsequently dismantled. The Benson mine in northern New York, west of the Adirondack mountains, has also installed a separating plant, and has produced merchantable concentrates in considerable quantity from lean magnetites. The Lake Champlain district has been prominent in the efforts to beneficiate ores by concentration by the use of jigs, and also by magnetic separators. At the Port Henry mines is the largest separator plant in the country.

New York is one of the few states where, in addition to the magnetites, the three other varieties of iron ore are found. Red hematite is mined from the north central portion of the state, in Jefferson, Clinton, and Oneida counties; brown hematites are won in the southern portion, east of the Hudson river, in Dutchess and Columbia counties, and in the same district carbonate ore has been found to a considerable extent, and a large plant for roasting these ores has been constructed near Catskill Landing.

Some of the brown hematite mines along the Harlem Railroad have been worked for many years, and have been, and are still, the main reliance of the charcoal iron industry along the Connecticut and New York boundary. This same class of ores extends into Litchfield county, Conn., and Berkshire county, Mass., the district being generally recognized as the Salisbury region. The rapid denudation of available timber, and the necessity of operating small blast furnace plants producing a special grade of pig iron, has reduced the number of furnaces, so that now only a few are making iron with charcoal; these smelt brown hematite and some carbonate ores.

In addition to the brown hematite ores mentioned as

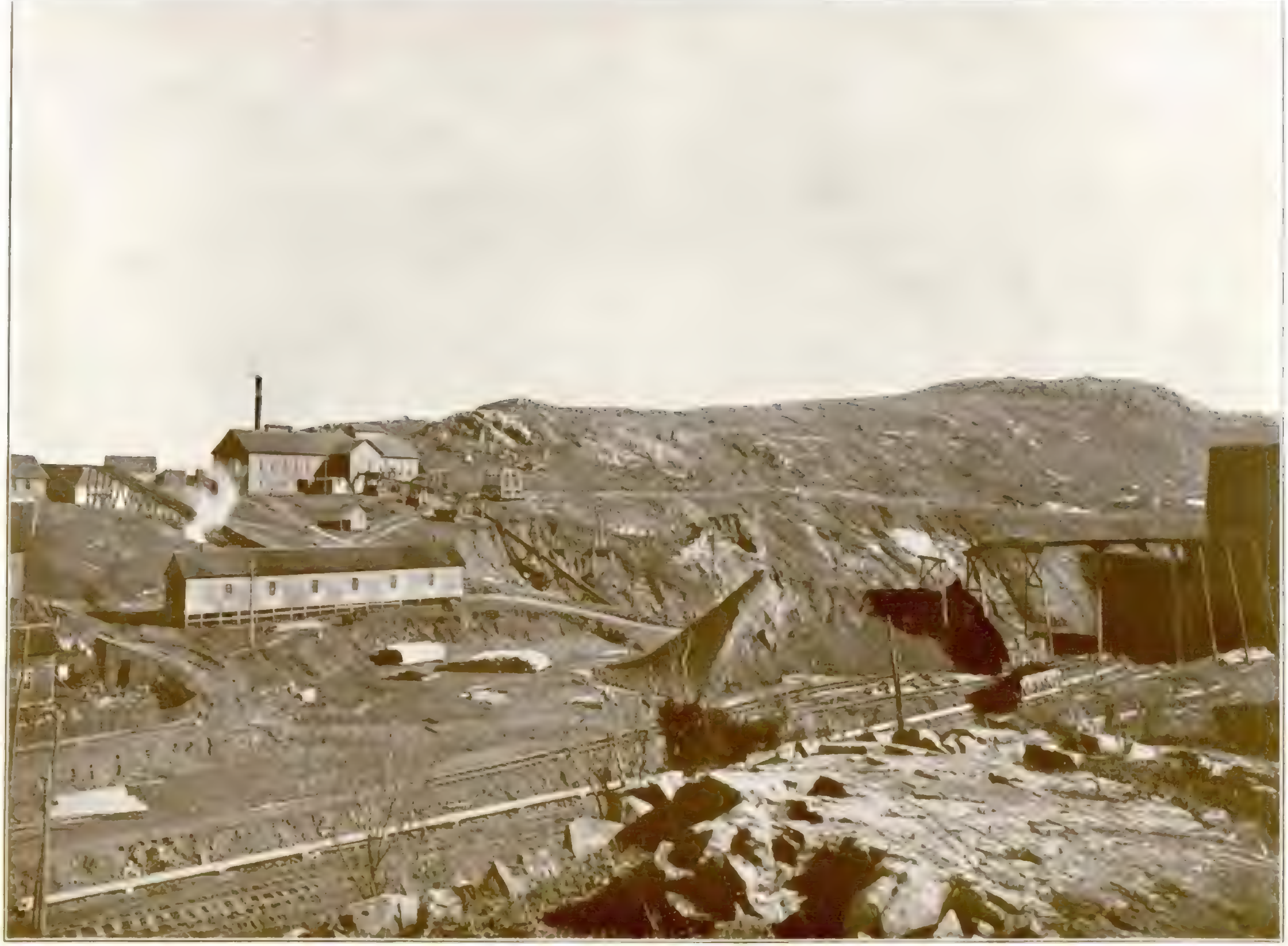

PLATE IX.—THE SALISBURY MINE, MARQUETTE RANGE, MICHIGAN.

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occurring in southwestern Massachusetts and northwestern Connecticut, bog ores are found in eastern Massachusetts, and were the foundation upon which the first practical development of the iron industry in the United States was based. Magnetic ore occurs in Rhode Island, and magnetites and brown hematites have been mined in Maine and Vermont.

New Jersey.—The magnetite ores extending from New York across northern New Jersey into Pennsylvania, have been liberally developed in a number of locations in New Jersey. The importance of the industry, however, has declined in late years, the bulk of the product being confined to a few of the more important mines. As a rule, the ores of New Jersey are lean, and some of them carry sulphur or phosphorus in excess, but others are of Bessemer grade. In western New Jersey magnetites also occur in a decomposed condition, and carry considerable manganese. Brown hematites are found in western New Jersey, in the vicinity of Belvidere, but have not been extensively developed. The early iron industry of New Jersey was based upon the use of bog ores, which came from the district close to the ocean front; these are no longer used, and all of the ore won in New Jersey is of the magnetite class. The beneficiation of magnetic ores by washing and by separation has reached a development in New Jersey approximating that of the state of New York. The failure of some of the more pretentious magnetic separating plants, which comminuted ore finely, has encouraged magnetic cobbing and the treatment of ore as coarse grains by separators. The roasting of dense ores is also a feature of New Jersey blast furnace practice.

Pennsylvania.—Pennsylvania, although not the pioneer in American iron industry (its initial enterprise having been established about 1716), rapidly advanced to first place, and by reason of the wide distribution of all classes of iron ore and abundance of fuel, became the largest producer of iron, and still holds that rank, although the bulk of the iron ore used in the manufacture of its iron and steel products is mined outside of the state.

The most important iron mining operation in Pennsylvania is that carried on in the Cornwall ore deposit in Lebanon county, which has produced about three-fourths of a million tons annually, and, since the year 1740, has contributed a total approximating eighteen million tons to supply Pennsylvania iron works. This ore as mined yields on the average about 46 per cent of iron, carries about three-fourths of 1 per cent of copper, and about 2½ per cent of sulphur. It must, therefore, be roasted, and ore-roasting kilns have here obtained their largest development. Furnaces of the Gjers cylindrical form, using solid fuel, are used at some plants, and at others there are circular or rectangular kilns heated by producer gas after the Davis-Colby patents.

The Cornwall ore bank, at Cornwall, Lebanon county, is a large deposit of magnetite from which immense quantities of ore have been won. Most of the ore is obtained above water level, cars being run in on a series of terraces. The ore is broken down and loaded onto cars by means of barrows, and thus transported to the furnaces.

Plate XIII shows two terraces in solid ore, with the workmen engaged in filling the ore cars. In the background of the picture a stripping which covers the ore can be seen.

Along the South mountain, from the Delaware river to and beyond the Susquehanna river, deposits of magnetic iron ores are found and have been worked. In Lehigh and Lancaster counties at present they are mined chiefly for concentration, as the ore is lean. In Berks county a large underground development was made at Boyertown, some shafts extending over 600 feet in depth, the ore being, as a rule, low in phosphorus but high in sulphur, and requiring roasting. These mines are being unwatered to make it possible to obtain ore. Between Boyertown and Cornwall a number of magnetic deposits have been worked spasmodically, and beyond the Susquehanna, in Adams and York counties, similar mines have been in operation. In Lancaster county a magnetic concentrating plant has lately been installed, operating on a large mass of lean magnetite, which is crushed, sized, and separated, the object being to form the concentrates into briquettes for use in blast furnaces.

Along the northern and western faces of the South mountain, and in the valley between the South and North mountain ranges, brown hematite ore has been mined in many localities, some of the deposits having been worked on a liberal scale, and others, producing but little, have a history approximating a century of time. As a rule, these brown hematites require washing to make them desirable for blast furnace purposes, and they yield, after such treatment, about 45 per cent of iron, some with 2 to 5 per cent of manganese, and all with phosphorus above the Bessemer limit. Other brown hematites of nearly similar composition occur in central Pennsylvania, along the eastern flank of the foothills of the Allegheny mountains, in Bedford, Center, Huntingdon, and other counties. In the same region fossil and red hematites are won by underground operations, and this is true also of deposits in northeastern Pennsylvania, along the Blue mountain range, and in the vicinity of Danville and Bloomsburg. Practically all of the brown hematites have been won from open cut workings, the ore occurring with clay and limestone, and requiring washing. Much of the red hematite was mined from small underground drifts.

In the bituminous coal belt, which extends across Pennsylvania from northeast to southwest, with the Allegheny mountains as an axis, the carbonate ores obtained were formerly an important base of supply. The location of many of these ores in small veins, the exploitation of which is expensive, the necessity of roasting them, and their generally high phosphorus content have much limited their use.

Delaware and Maryland.—In Delaware there are several isolated deposits of brown hematite which have been worked but are now inactive. In eastern Maryland carbonates which occur mixed with clay are mined in a desultory way by farmers and used near the city of Washington to produce a special grade of pig metal with charcoal. In western Maryland there are brown hematites in considerable quantities, also indications of red hematites, and some lean magnetites, which, while appearing to occur in large proportions, would have to be concentrated to be merchantable.

The Virginias and Carolinas.—In Virginia the bulk of the iron ores mined are of the brown hematite class, some occurring in beds of clay, others in a form approaching veins embedded in rock strata. Minor deposits of red hematite also exist, and in southwestern Virginia and in western North Carolina there are large bodies of magnetites. Titaniferous magnetites and brown hematites occur in central North Carolina and extend into South Carolina, Georgia, Tennessee, and Alabama.

The Appalachian mountain chain is bordered by iron ore deposits from northern New York through New Jersey, Pennsylvania, Maryland, the Virginias, North Carolina, Tennessee, Georgia, and Alabama. These deposits are mostly magnetites and brown hematites, the latter generally showing in the valleys, the former often in foothills or on the slopes of the mountains. Some red hematites are also found on the mountain slopes. Nearly paralleling the Appalachian range, and occupying positions in the foothills of the Allegheny mountains, are deposits of brown hematite, also of carbonates. The carbonates are more abundant in the coal bearing regions, and occur on both flanks of the Allegheny mountains.

Still farther west carbonate ores and some brown hematites are found in the coal measures of western Pennsylvania, West Virginia, Ohio, Kentucky, and eastern Tennessee; red and brown hematite are abundant in Kentucky and Tennessee.

Ohio.—The ores obtained from Ohio and from the portion of Kentucky adjacent to the Ohio river are either carbonates or hematites, resulting from the weathering of carbonates; these have sustained a considerable iron industry for many years in southern Ohio and in Kentucky, in a locality known as the Hanging Rock region, with Ironton, Ohio, and Ashland, Ky., as business centers. The original installations were all charcoal furnaces, some of which are still active; for a time some furnaces used raw bituminous coal, but the larger plants are now dependent on coke, local ores being used, supplemented by other ores from the Lake Superior region.

There are also in Kentucky excellent deposits of limonite, and these extend into Tennessee, some quite important mines existing in the central and western portions of the state. There are also carbonates in the southwestern section which extend into Mississippi. Carbonate ore also exists in northern Florida.

Wisconsin and Iowa.—The liberal exploitation of the iron ores in the Lake Superior region has directed attention to deposits in adjacent states. In central Wisconsin brown hematite exists in pockets or lenses. In southern Wisconsin there is a unique deposit of high phosphorus red hematite ore, which, owing to its physical structure, is known as flaxseed ore, and an apparently large quantity of red hematite of excellent composition has also lately been discovered by drilling and shafting in the vicinity of North Freedom, Sauk county, Wis. This deposit is expected to be a factor in the iron ore supply of Chicago and vicinity. In northeastern Iowa brown hematites have been wrought, and carbonates are found in the western section of the state.

Missouri and Arkansas.—Missouri attained prominence as an iron producing state several decades ago through the Iron Mountain and Pilot Knob deposits, which gave promise of being large producers, but as development proceeded these ore beds were practically exhausted, although it is possible there may be undiscovered extensions of them. In central, eastern, and southern Missouri red hematite and brown hematite ores are obtained in quantities, and these ores also extend into Arkansas, although there has been no development in that state.

Texas.—The exploitations for iron ore in Texas have been chiefly in the northeastern section, where brown hematites have been won from near the surface, and the fact that these lie in nearly horizontal layers, covered but slightly with a ferruginous sandstone and sand, suggests that they are bog ores forming the bottom of an extinct lake. They extend over a large territory, except where the plateaus are cut by water courses. In central Texas an important deposit of red hematite ore, claimed to be of excellent quality, has been opened up, but in the absence of demand for this mineral exploitation has not been prosecuted.

Rocky Mountain region.—The section of the country which may be considered as the Rocky Mountain region has a number of important deposits of iron ores and all the general classes of ores are found. In what might be called the distinctively mountainous section, on the western slopes, magnetites are obtained, and some deposits of apparent magnitude are known to exist, but owing to the high elevation of the deposits and the amount of snow encountered, they have not been exploited. It is possible that the increasing demand for iron ores may encourage development.

The iron ore deposits at Sunrise, Laramie county, Wyo., are quite extensive; until late years, however, but little ore had been produced from them. The ore is a red hematite occurring in carboniferous lime-

PLATE X.—RED HEMATITE MINE, RED MOUNTAIN, NEAR BIRMINGHAM, ALABAMA.

PLATE XI. LIMONITE BANKS NEAR TECUMSEH, CHEROKEE COUNTY, ALABAMA.

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stone; covers, as it is claimed, a superficial area of about 20 square miles; contains from 60 to 67 per cent of iron from 2.5 to 5 per cent of silica, and is low in phosphorus. It is won by open cut working, as shown in the illustration, the steam shovels loading onto cars on which it is taken to the furnaces at Pueblo, Colo. The view (Plate XIV) shows the ore *in situ* together with the covering of limestone and earth.

In New Mexico there is a deposit where red hematite and magnetite ores are obtained. The Fierro, or Union Hill, and Jim Fair mines are located in the territory of New Mexico, near Hanover. Mr. D. M. Barringer, M. E., states that the ore generally, but not always, occurs with eruptive granite and limestone, probably carboniferous, the vein being vertical or dipping at a steep angle. The ore of the Union Hill mine is a mixture of approximately 75 per cent magnetite and 25 per cent hematite, and is quite hard.

The ore of the Jim Fair mine is of practically the reverse composition to that of the Union Hill, the greater portion being of the hematite variety, and is also quite hard. Both here and at the Union Hill mine the ore stands in dikes, and is quarried out in open cuts. Mr. Barringer states that at one place there is a large deposit of brown hematite ore, and at one point there is also a considerable amount of specular ore. The ore carries satisfactory percentages of iron, and is of Bessemer quality. The permanency of this deposit does not seem assured from the results of mining operations to date.

In the San Luis valley of Colorado, which may be said to be in the heart of the Rocky mountains, brown hematite ores are mined, and one mine has been phenomenal not only for the quantity taken from it, but also for the low percentage of phosphorus in the ore. In fact, the product has been persistently a Bessemer ore, and it is probable that no other deposit of brown hematite has produced as much low phosphorus ore as the Orient mine. This mine is located in the eastern part of Saguache county, Colo., about eight miles from Villa Grove, and was opened in 1882. The ore body is from 30 to 150 feet in width and is worked by means of tunnels, from which stopes are run. Over 1,000,000 tons of ore have been obtained from this deposit, but unfortunately it shows signs of exhaustion. It may be, however, that deposits of similar character will be found in the same district.

Plate XV is a view of the Orient mine, showing one of the inclines from which the ore is loaded onto cars for transportation to the blast furnace.

Between the Pacific coast and the Rocky mountains there are a number of deposits of iron ore, but few have been exploited, because there has been little or no market for the mineral. Blast furnaces which were located at Ogden, Utah, at Clipper Gap, Cal., and at Salem, Oreg., have ceased operations, and the only enterprise now active is near Port Townsend, on Puget sound, in the state of Washington. This plant has drawn its supply in part from local hematites (bog ores), but is largely dependent upon magnetic ores imported from British Columbia. The plants now idle relied, when in operation, mostly on brown hematite ores mined near the furnaces, with the exception of the plant in Utah which received as part of its supply red hematites from Wyoming. In northern and southern California magnetites and red hematites are reported, but nothing beyond exploratory work has been done upon them. When satisfactory supplies of metallurgical fuel become available it is possible that some of these Pacific coast deposits may be exploited. Magnetite has also been mined near Lovelocks, Nevada.

VALUE OF IRON ORE DEPOSITS.

The determination of the value of iron ore deposits is difficult, for they are only serviceable in so far as the material of which they are composed may be utilized. Thus, a mountain of excellent iron ore remote from blast furnaces or other means of utilization, without transportation facilities to carry the mineral to points where markets exist, would stand practically useless until these conditions were modified.

The quality of the iron ore obtainable has a decided influence upon the value of the product, and therefore upon that of the deposit. Ores low in phosphorus, although with moderate iron content, command premiums over those carrying this element in excess, and in the present state of metallurgical development ores carrying titanium are considered undesirable, although in the near future they may possibly be sought after. A sulphurous ore requiring roasting is less desirable than one free from sulphur, and ores which require washing or beneficiating, either by jigs or magnetic separators, have less value than those which can be used in their native state. Therefore, the apparent quantity and average quality of an ore in a deposit and its accessibility to markets or prospective points of consumption affect its value. Where a mine is producing and where the tests made to determine the apparent extent of the deposit are satisfactory, its value may be gauged by capitalization based upon a royalty charge for ore mined, for in an ore deposit the material taken out is not reproduced, and therefore some allowance covering a value for the ore won is proper.

The difficulties of determining the value of iron ore deposits are increased by the fact that in some instances mere mining rights are granted, while in others a proprietor may allow a mining company to take ore at a fixed rate per ton, or upon a sliding scale. In still other cases the ownership is in a state which grants mining leases at tonnage rates; these leased properties after having been explored or developed are sublet, and thus two or more royalties may be cumulative. A deposit of ore has no definite value to the lessee or sublessee, other than what he gets out of it during the term of his lease, for he has no interest in its future and the owner can practically base no estimate of value except by capitalizing its earning capacity, providing that earning capacity can be maintained. Another feature which has caused trouble in an attempt to determine approximate valuations for the iron ore deposits of the United States has been that a company may own or lease a considerable tract of land only a small part of which has been explored or exploited. It would be manifestly unfair to base an estimate of the value of the entire property upon results obtained from a limited area.

During July, 1902, an interesting suit in chancery developed the estimate which the officers of the United States Steel Corporation placed upon its iron ore properties. Practically this estimate claimed that the corporation had in reserve, in deposits which had been tested, over 700,000,000 tons of iron ore, upon which the company placed a value to itself of $1 per ton. This was not merely a royalty estimate, but represented what the officers of the corporation considered the ore was worth as a material for conversion into merchantable products, taking into consideration the location of the deposits in relation to its furnaces and mills, and the fact that as far as known this supply could not be duplicated elsewhere, certainly not within any limit of transportation to the corporation's existing plants. This valuation was questioned because an official of the corporation had stated that it had reserves of ore and fuel sufficient for sixty years, the assumption being that the value of a supply of mineral which would not be exhausted before sixty years would be strongly affected by the interest which the money invested should earn in that time. In a case such as indicated, an iron ore deposit which produces a quantity of ore desirable in quality, so as to be of material service to the industry, undoubtedly possesses a value to the owners which is not fully measured by a mere royalty charge, for it acts as a basis for supplying raw material and gives the owner not only a possible profit on the mining, but a protection in cases of fluctuations in prices of ore, a value difficult to estimate in money.

COMMERCIAL VALUE OF THE PRODUCT.

The determination of the value of iron ores is contingent upon the character of each ore, its chemical components, its texture, its location in relation to blast furnaces where it can be used, and transportation facilities. The custom heretofore followed in census reports of ascertaining as closely as possible what commercial value the various ores represent at the mines, including any royalty or allowance for royalty, and excluding all transportation charges has been followed in this report. In discussing the output by states, the value of the ore delivered at points of consumption is not taken into consideration, but comparisons are based upon what the ores are commercially worth at the mine ready for market. The value, however, should and does include the cost of beneficiating ores when they receive such treatment, so as to make the record show the total value of the iron ore produced in each state.

The prices of the Lake Superior ores of Bessemer quality are based on a standard ore yielding 63 per cent of iron when dried at 212° F., with 0.045 per cent phosphorus and 10 per cent moisture, equivalent to 56.7 per cent of metallic iron in the natural condition. The standard for non-Bessemer ores yields 60 per cent of iron when dried at 212° F., with 12 per cent moisture, equivalent to 52.8 per cent metallic iron in the natural condition. The calculation to determine the selling price is made on ores having the above hypothetical analysis, delivered f. o. b. cars at blast furnaces. If the ores yield above or below the chemical standard the price is adjusted accordingly by premium or discount. The scale for Bessemer ores takes into account the percentage of both iron and phosphorus. The price of non-Bessemer ores is determined in the same way, but usually only metallic iron is taken into consideration unless other constituents are excessive.

The physical condition of iron ores—that is, whether they are coarse or fine, dense or open in structure—also affects their commercial value. The Mesabi range ores are divided into three classes, according to their degrees of fineness, as determined by sieve tests; the second class is 10 cents, and the third class 25 cents below the price placed upon the first class.

All of the ore mined in the United States is not utilized in the production of metal for steel manufacture, for in this freedom from phosphorus is generally necessary; an excess of this element, however, is admissible in iron treated by the basic Bessemer process.

For use in foundries, for treatment in puddling furnaces, and for other purposes which, taken together, consume approximately one-quarter of the pig iron produced, the limitations as to phosphorus are less rigid. For these purposes many ores may be smelted which are not considered desirable in manufacturing pig iron for conversion into steel. However, other elements than phosphorus demand consideration, and in the selection of ores their chemical composition determines their availability for specific use. The percentage of iron which an ore yields is the first consideration, for upon this the economy of smelting primarily depends, but objectionable elements or oxides may encourage the selection of an ore containing less metallic iron, but freer from objectionable constituents than an ore with high iron contents associated with deleterious ingredients.

Seeking for large outputs of metal of a particular composition, and for low fuel consumption, blast furnace managers may refuse nearby ores lean in iron or carrying undesirable constituents, and bring from a

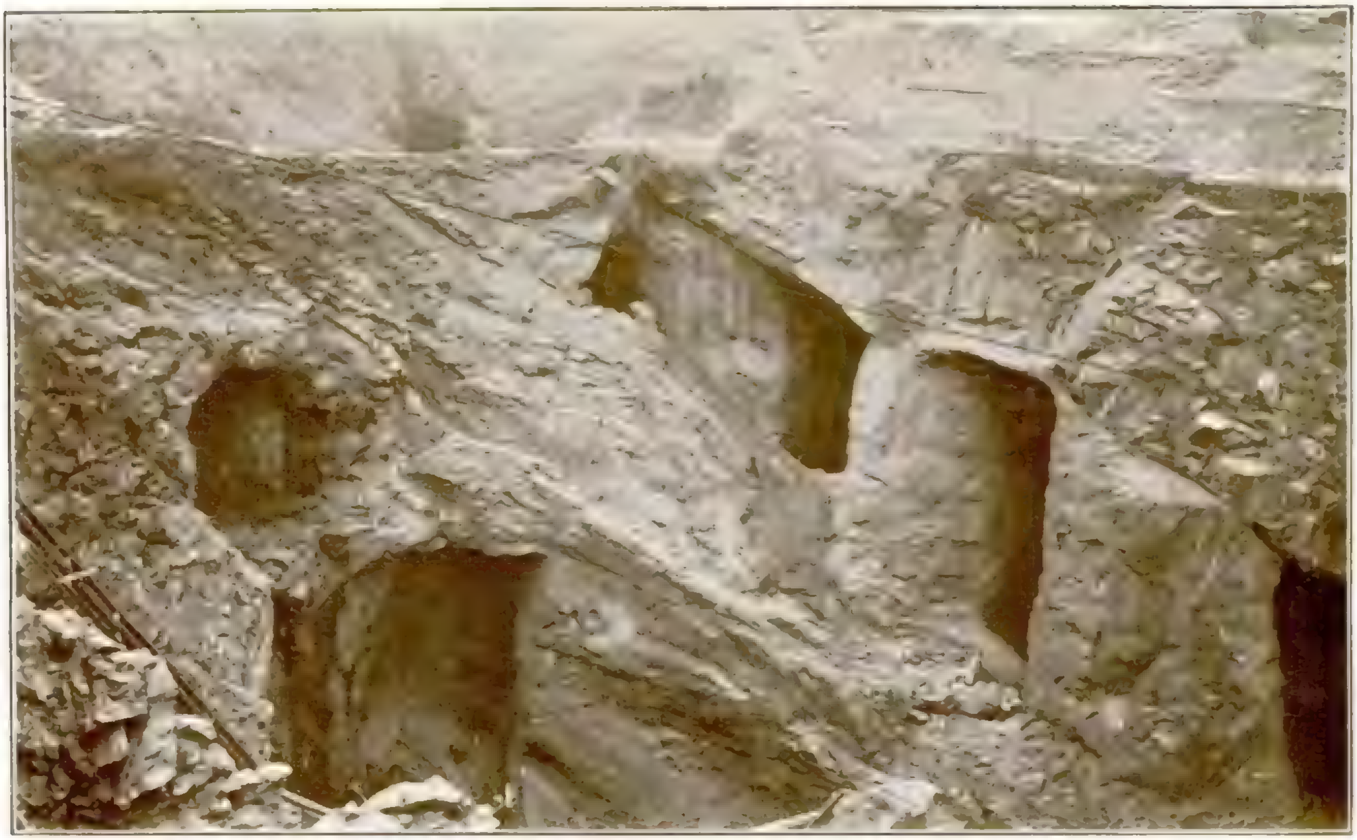

PLATE XII.—VIEW OF NO. 21 MINE, PORT HENRY IRON COMPANY, MINEVILLE, NEAR PORT HENRY, NEW YORK.

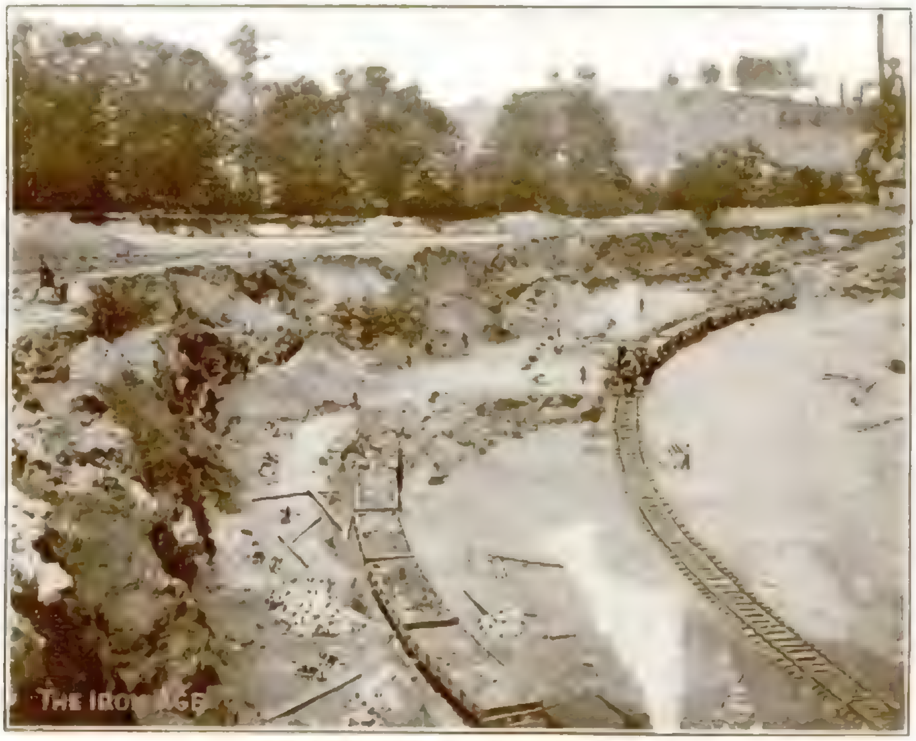

PLATE XIII.—CUT IN MIDDLE HILL, CORNWALL ORE BANKS, CORNWALL, LEBANON COUNTY, PENNSYLVANIA.

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distance ores with larger percentages of metal or with very little of phosphorus, sulphur, titanium, etc.

The following table shows the quantity of iron ore produced in each state and territory in the United States, its value, and the average value per ton, for each year from 1899 to 1902:

TABLE 13.—QUANTITY, VALUE, AND AVERAGE VALUE PER TON OF IRON ORE, BY STATES AND TERRITORIES: 1899 TO 1902.

STATE OR TERRITORY.	1902			1901			1900			1899		
	Quantity (long tons).	Value.	Average value per ton.	Quantity (long tons).	Value.	Average value per ton.	Quantity (long tons).	Value.	Average value per ton.	Quantity (long tons).	Value.	Average value per ton.
United States	35,567,410	$65,465,321	$1.84	28,887,479	$49,256,245	$1.71	27,553,161	$66,590,504	$2.42	24,683,173	$34,999,077	$1.42
Minnesota	15,137,650	23,999,227	1.58	11,109,537	15,385,513	1.39	9,834,399	24,384,393	2.48	8,161,289	9,924,883	1.22
Michigan	11,135,215	26,695,960	2.40	9,654,067	21,735,592	2.25	9,926,727	28,893,650	2.91	9,146,157	13,707,899	1.50
Alabama	3,574,474	3,936,812	1.10	2,801,732	2,587,719	0.92	2,759,247	2,629,168	0.95	2,662,943	2,601,609	0.98
Virginia and West Virginia	987,958	1,657,156	1.68	925,394	1,466,423	1.58	921,821	1,469,316	1.62	986,476	1,768,410	1.79
Tennessee	874,542	1,123,527	1.28	789,494	912,849	1.16	594,171	669,087	1.13	632,046	694,372	1.10
Pennsylvania	822,932	1,225,155	1.49	1,040,684	1,561,620	1.50	877,684	1,890,108	2.15	1,009,327	1,991,772	1.97
Wisconsin	783,996	1,800,864	2.30	738,868	1,564,173	2.12	746,105	2,081,272	2.79	579,798	837,766	1.44
New York	555,321	1,362,987	2.45	420,218	1,006,231	2.39	441,485	1,103,817	2.50	443,790	1,241,985	2.80
New Jersey	441,879	1,228,664	2.78	401,999	918,011	2.28	344,247	956,711	2.78	256,185	814,920	3.18
Georgia and North Carolina	361,990	503,488	1.39	[1]215,399	258,227	1.20	395,186	446,354	1.13	284,364	307,965	1.08
Nevada, New Mexico, Utah, and Wyoming	[2]362,034	475,516	1.31	[3]234,514	367,864	1.57	[4]132,277	202,480	1.53	54,148	108,720	2.01
Colorado	306,572	1,084,424	3.54	404,037	1,284,255	3.18	407,084	1,510,831	3.71	307,557	749,734	2.44
Kentucky	71,006	86,169	1.21	[5]46,499	48,958	1.05	[5]55,057	60,886	1.11	35,384	35,384	1.00
Missouri	66,308	106,379	1.60	14,290	33,742	2.37	41,366	62,745	1.52	22,720	42,293	1.86
Connecticut and Massachusetts	[6]29,083	81,374	2.80	25,214	73,487	2.91	31,185	75,702	2.43	29,611	77,990	2.63
Maryland	24,367	46,911	1.93	21,218	33,825	1.59	26,223	55,735	2.13	3,428	4,628	1.35
Ohio	22,657	41,976	1.85	44,185	67,776	1.53	61,016	98,563	1.62	53,221	77,606	1.46
Texas	6,516	6,434	0.99	(7)	(7)	(7)	16,881	13,792	0.82	14,729	13,262	0.90

[1] Includes South Carolina.
[2] Includes Montana. No product reported for Nevada.
[3] Includes Texas and Montana.
[4] Includes Montana.
[5] Includes Iowa.
[6] Includes Vermont.
[7] Included with Nevada, New Mexico, Utah, and Wyoming.

The values at different mines vary greatly and only the averages are presented in the above table. In considering these values it must be remembered that they represent the labor employed and the expenses of operating, royalties, or sinking fund, but no transportation charges. These values are not the selling prices of the ores, which are gauged when delivered either at the furnace or at receiving points where they are handled for distribution.

MINING METHODS.

Iron ore deposits in the United States vary materially in character, size, and occurrence, and the geological and physical conditions of the several varieties generally known as magnetite, red hematite, brown hematite, and carbonate ores require different methods of exploitation which also vary greatly. The known character, the apparent dimensions, the general form, and the position of an iron ore deposit, with reference to the surface and water, the physical structure or chemical composition of the material to be extracted, the character of the earth or rock inclosing or occurring in the ore body, the stratification, dip, and strike, the simplicity or complexity of the ore body, the convenience of the deposit to an available market for its product, and the capital at command of those who attempt the exploitation all influence the methods followed in mining iron ore.

Where the ore body projects above or lies close to the surface, or where in a large apparently well defined deposit the cover can be stripped to advantage, the exploitation may be carried on by open cut work, from which the ore is taken out either by train or, after digging, lifted by steampower applied to inclines or to vertical hoists.

In the Mesabi range of Minnesota, in the Sunrise district of Wyoming, and in a number of brown hematite deposits of the South, large open cuts are worked by the use of the steam shovel, these appliances removing the ore in successive benches after large areas have been stripped by the same method.

Where the body of ore is under considerable cover, if the roof is firm, or if the vein matter is comparatively narrow and the dip steep, it is removed through shafts, either vertical or inclined, and through tunnels or adits. In a number of instances open cut work has, after reaching a considerable depth, been supplemented by underground exploitation, while in a few cases this method has been reversed and a large open cut has supplanted underground work. The shafts or adits, which are generally expected to serve as long as the deposit yields ore, are necessarily costly and need to be planned and located with care, for through these the miners have access to the underground workings, and the ore and water are carried to the natural surface.

Except when the strata penetrated are exceptionally compact and hard, the shafts or adits must be substantially timbered, so that they can be maintained until the deposit is exhausted; they are excavated either in the ore or in inclosing rock, and if in the ore large bodies are left adjacent to these avenues of approach as a safeguard against accident. From these main arteries drifts are opened either parallel or at different angles in wide or shallow deposits, or at determined depths in narrow and deep deposits, and from these in turn supplementary drifts are run and rooms or stopes excavated.

In deposits dipping considerably from the horizon one prevailing method of exploitation is to open a series of drifts at different levels, from which mining is carried on simultaneously; the upper levels are farther advanced than those below, the ore being taken out in horizontal sections or slices, known in mining parlance as stopes. When the ore is worked above a given level and allowed to fall by gravity, through chutes or otherwise, to vehicles which deliver it to the main arteries, the method is called "overhand stoping." Where the material is attacked below a level and the ore raised to this level, the method is recognized as "underhand stoping." The overhand system is, under most circumstances, the cheaper and more advantageous, but the underhand stoping is necessary in taking up floors, removing pillars, and in some open cut work.

In underground operations the space made void as the ore is removed must be protected, at least in part, either by timbering or by filling in rock or other waste material. In some instances the ore, if hard and if left in pillars alternating with rooms or stopes, will safely support the roof, but often the proportion of ore sacrificed is too great to make this method desirable.

After shafts or adits have been sunk and main drifts run the ore is taken out by various systems, which may be briefly designated as follows:

"Milling," in which the surface earth is removed and the ore drawn through "raises" into drifts located some distance below the top of the ore, thus making large sinks or craters. This system requires that the cover be stripped, and is especially adapted to moderately shallow deposits of soft ore covering a large area.

In "caving" a series of levels connecting with the main shaft or with several shafts are simultaneously worked, the ore being taken out from the upper levels and delivered through winzes to lower levels which are protected by the ore *in situ*. As the ore is removed from the portion of one level the superincumbent rock or earth is allowed to cave upon the ore below, and frequently the settling of the material is facilitated by the use of explosives. By this method but little ore need be left in a deposit, and if care is exercised the risks are not great and but little waste becomes mixed with the ore. This method is applied more to soft or moderately soft ores than to those which are harder, but it is used in some hard ore mines where the roof or hanging wall is insecure.

"Drifting" is employed in all underground mining, but where a series of parallel drifts, one advanced more than another, are employed to slice off the deposit the method is specifically known as the "drifting or slicing system."

"Room mining" may be considered either as digging out cavities which alternate with pillars, or as opening cavities of considerable length, width, and height, usually from foot wall to hanging wall, and supporting the last named and the roof by an elaborate arrangement of timbers known as square sets, in which the timbers are so placed as to form the outlines of a series of cubes resting upon one another by carefully fitted joints. This method is largely employed in removing soft hematite, and some of the cavities thus made and protected are of enormous size.

"Filling" is not so much a method of mining as a means of protecting the workings by depositing in the cavities waste rock, sand, and other refuse. This method is often more economical than timber support, and is adapted to hard ore mines.

The magnetites, as a rule, are found in fairly well-defined veins, inclosed between walls and dipping at steep angles from the horizon. Some of these veins are of enormous size, as in the Lake Champlain district of New York, where the texture and hardness of the ore permit of its use as pillars in the mines. Other veins are narrow and tortuous, although persistent, and each of these characteristics demands different methods of exploitation.

Where magnetic iron ore is obtained from underground operations the ore left as pillars generally furnishes sufficient support for the roof. There have been instances where the proportion of the total ore in the deposits which these pillars represented was so large, or the tendency of the mineral to break from the pillars in large masses was so great, as to cause their abandonment.

FINE ORES.

During late years there have been interesting discussions in the technical press concerning disturbances in blast furnaces, which are attributed largely to the increasing use of finely comminuted iron ores. The troubles have been emphasized by the contemporaneous development of the Mesabi range in Minnesota, where a majority of the ores occur finely comminuted, some practically as powder, by the use of concentrated ores, and by the increase in the dimensions and power of blast furnaces. As a result, fine ores have been discredited, and explosions, slips, and losses in the blast furnaces have been attributed to the use of these ores. Fine ore is undoubtedly more troublesome in the blast furnace than ore which is of moderate size, as the comminuted material is liable to sift down through the charge and accumulate in portions of the furnace, increasing the resistance of the blast, and a portion as flocculent material is carried over with the furnace gases. In some blast furnaces the latter represents so large a proportion of the ore charged that the material

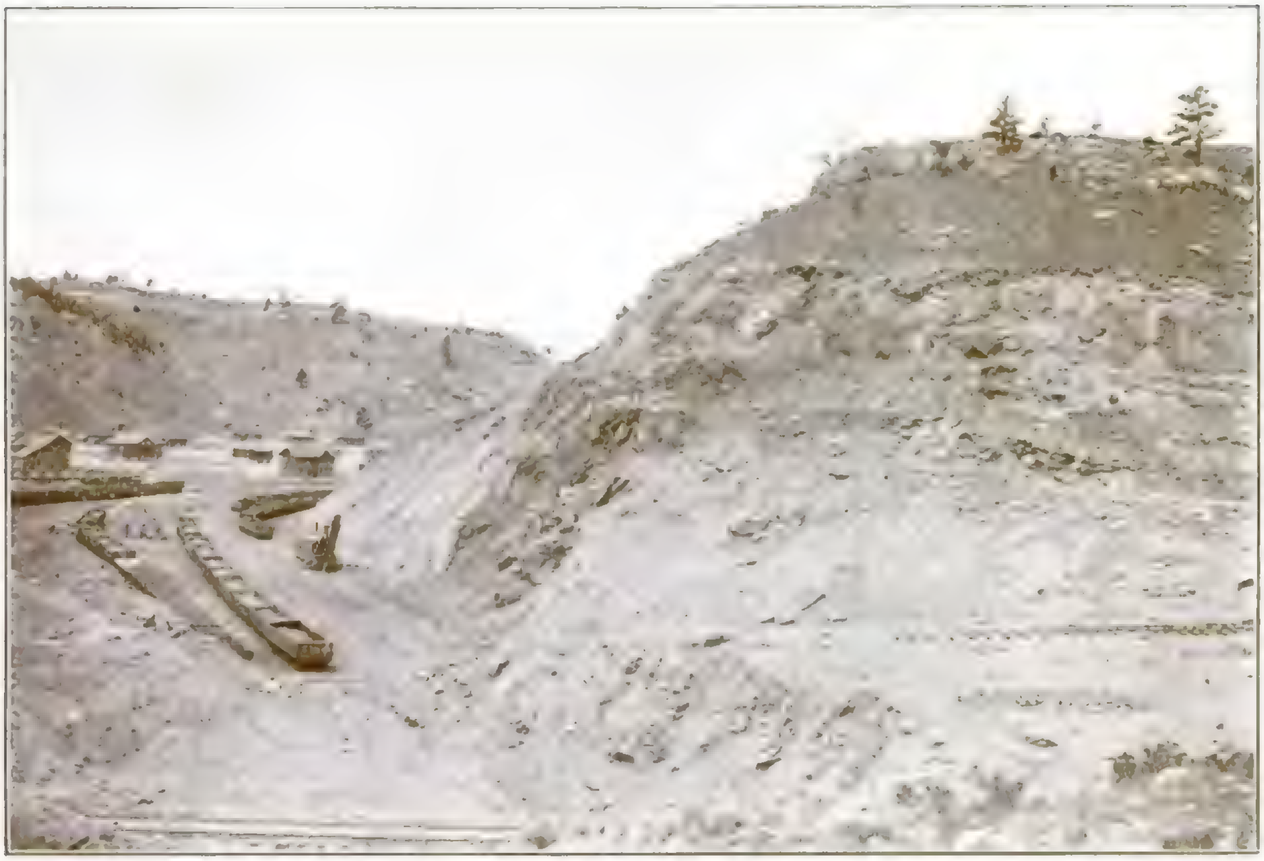

PLATE XIV.—SUNRISE PIT FROM THE EAST, AT SUNRISE, LARAMIE COUNTY, WYOMING.

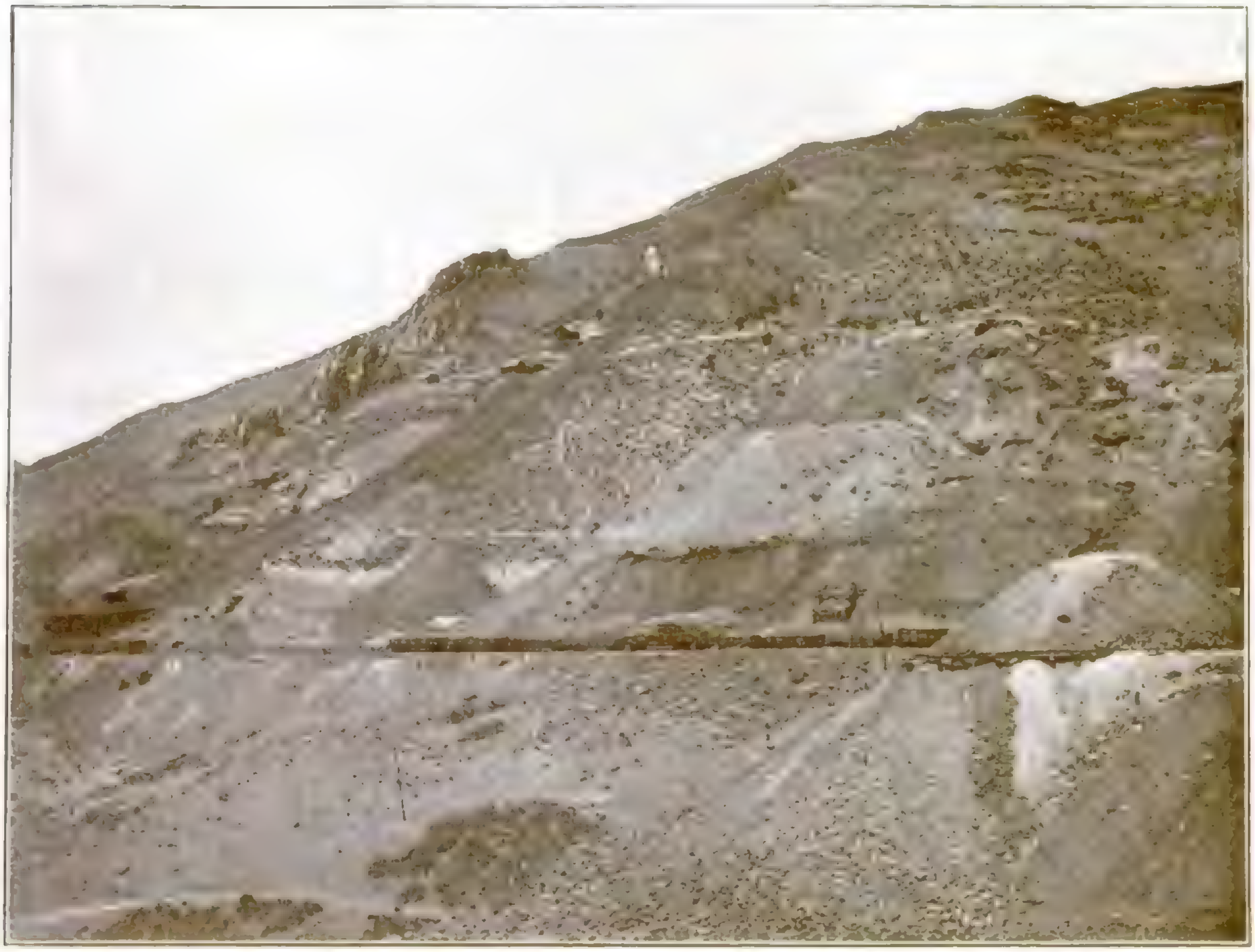

PLATE XV.—NOS. 3 AND 4 TRAMS AND RAILROAD TRACKS, ORIENT MINE, NEAR SALIDA, SAGUACHE COUNTY, COLORADO.

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is recovered and formed into briquettes, or made into mud with water, to be returned into the furnace.

There is no intention to question the desirability of using relatively coarse ores in blast furnaces, but it is probable that fine ores are blamed for some disturbances for which they are only partially responsible. The accumulation of fine material of any kind in a portion of a blast furnace may cause unequal settlements, slips, or irregular operation, and, while the fine ore is subject to this, the same results may come from an accumulation of comminuted coke and fluxes. In the enlargement of blast furnaces the system of feeding materials has been radically changed. Where thousands of tons are fed daily into the throat of a blast furnace, the handling of this becomes an important matter, and labor-saving appliances are demanded. A few years ago the general practice of blast furnaces, of what was then large size but would now be considered of moderate dimensions, was to discharge the raw material from cars running upon trestles, shovel or fork this into charging buggies which were elevated to the top of the furnace and discharged upon the bell, which closed the throat by fitting against the hopper. But where large quantities are daily handled bins have been introduced which take the place of trestles, and the material, instead of being shoveled or forked into the discharging buggies, drops from railroad cars into bins and from bins through chutes into scale or weigh cars, thence into skip cars, which are lifted considerably above the top of the furnace and dumped into the receiving hopper, thence through a bell and chamber to the main furnace bell.

Bins have been erected to considerable height, and in dumping the material, particularly coke, into the bins, or in passing it through them, it becomes more or less broken. At some furnaces the coke bin discharges immediately into the skip car running to the top of the furnace, but in a majority of cases the weigh car intervenes. As a consequence, a large percentage of coke is ground to powder, for it may have an aggregate drop of from 30 to 50 feet from the time it leaves the car in which it is transported until it touches the main bell of the furnace.

In the smelting operation there is no opportunity for coke to be consumed until it approaches the tuyeres of the blast furnace, for it is here that the combustion of the fuel is made possible by the admission of heated air. An excess of free oxygen would carry this combustion to a point which would result in imperfect and irregular furnace operation, consequently the fine material which may accumulate in the shaft or upper portion of the furnace may be added to until it is in such volume and position as to cause a disturbance by slipping, resulting in increased pressure of blast, and an irregular working of the blast furnace. While the same may be true of the fine ore, this has the advantage of being reduced by the gases resulting from the combustion of the fuel. Investigations of some of the larger furnaces blown out for repair seldom show unreduced ore, although the proportion of fine ore fed may have been large, but indicate volumes of coke dust adjacent to the walls or accumulated in different portions of the blast furnace. The combination of fine ore and fine coke may therefore be considered largely responsible for many slips and irregularities, but it is possible that explosions which have been so severe at a number of furnaces are attributable primarily to flocculent incandescent carbonaceous matter (resulting from the grinding of the coke), meeting oxygen under conditions similar to those in coal mines, flour mills, and grain elevators.

The quantity and chemical character of the fine ores which are available demonstrate the necessity of their use, and it is the duty of those designing or operating blast furnaces to provide for such utilization, and where satisfactory operation is secured under disadvantage the manager of a plant is entitled to proper credit for overcoming difficulties. The constructor must take into consideration the handling and distribution of this material, and also design and equip the furnace to meet the excessive pressure or unequal settlement which may be traceable to the fine ores, whether associated with fine coke or not. The latter condition will exist to some extent in any furnace, although for the reasons given above the quantity of fine coke is undoubtedly greatly magnified in the recent method of handling the materials. Ores which cost at the furnace 5, 6, or more cents per unit of metal can not be wasted with impunity, and where it is found impracticable to control the loss of fine ore through the gas flues, the collection of these, and their preparation for subsequent treatment, demand attention. The briquetting of fine ores, whether in their natural state or after beneficiation, is also commanding attention. Whenever an iron ore is handled and rehandled, passed through any mechanical apparatus, or heated, there is additional cost placed against it, and this cost will naturally affect the price of pig iron. However, it may be assumed as an axiom that the treatment of ores preliminary to their being fed into the blast furnace can generally be considered as more economical than depending on the furnace to do the work.

Methods of cheaply beneficiating and briquetting fine ores so as to introduce them into the blast furnace, and permit of their being carried down into the zone of reduction before changing form, seem to present a possible feature of advance, to which those interested in the smelting of iron can well afford to give attention.

While fine ores are considered by many managers undesirable, there is also objection to the mineral being of large size, especially in dense magnetites or red hematites. Preliminary crushing to approximately uniform size is therefore desirable, and to meet furnace requirements large crushing plants are in use at some important mines, the purpose being to reduce the hard ores to sizes convenient for handling and adapted to quick reduction.

CONCENTRATION OF IRON ORES.

In various parts of the country there are deposits of iron ores of considerable magnitude in which the amount of metallic iron is insufficient to justify the mining of the mineral and its use in blast furnaces. Some of these deposits are located so that the ore can be cheaply mined, and are also convenient to transportation facilities to market.

To reduce the percentage of gangue and to produce material carrying iron sufficient for economical smelting, these ores need to be beneficiated, and usually they are comminuted by crushing or grinding if they are not naturally of a size suitable for the purpose. After reduction in size the ore is either passed through jigs, where in connection with water the iron oxide separates from the gangue by specific gravity or the fine material is delivered to magnetic separators. The separation in jigs is effected when the specific gravity of the iron oxide and the gangue differ sufficiently to permit of a good separation. In magnetic separation the magnetic particles are attracted to belts, drums, or to stationary magnets and the gangue or such portion as is feebly magnetic is rejected. In either process time and the degree of comminution are elements in securing satisfactory results. Magnetic separation is confined to the treatment of lean magnetic ores or to hematites which are made magnetic by preliminary roasting, although some of the apparatus used discriminates satisfactorily between minerals of moderately different magnetic quality.

The size of the grains of ore intermixed with the gangue determines the possibility of perfection being approached by either system of concentration. But in many ores these grains are so small that the comminution required adds greatly to the cost, and also produces material whose desirability for smelting purposes is limited. Consequently, most of the concentrating plants do not attempt to attain perfection in separation, but produce a concentrate which, while below the possible standard of purity obtainable, is acceptable to the blast furnace managers because of the size of the grains. It is found to be advantageous to lose a portion of the mineral in the tailings rather than to attempt perfection with the separators. In some cases the tailings, when practically free from iron, are re-treated because of the value of these by-products. The sand resulting from a siliceous ore finds a ready sale, and the apatite separated from high phosphorus magnetite is in demand for fertilizing.

The magnetic separators in use in the United States in 1902 produced 192,285 long tons of commercial ore. Most of this was magnetite ore. In addition a cobbing method was used, wherein ore of considerable size was treated by magnetic separators. The possibilities of producing an ore rich enough for smelting purposes from some of the large deposits of lean magnetite have encouraged the introduction of a number of forms of separators, only a few of which, however, have proved of sufficient economic importance to be used.

ROASTING IRON ORES.

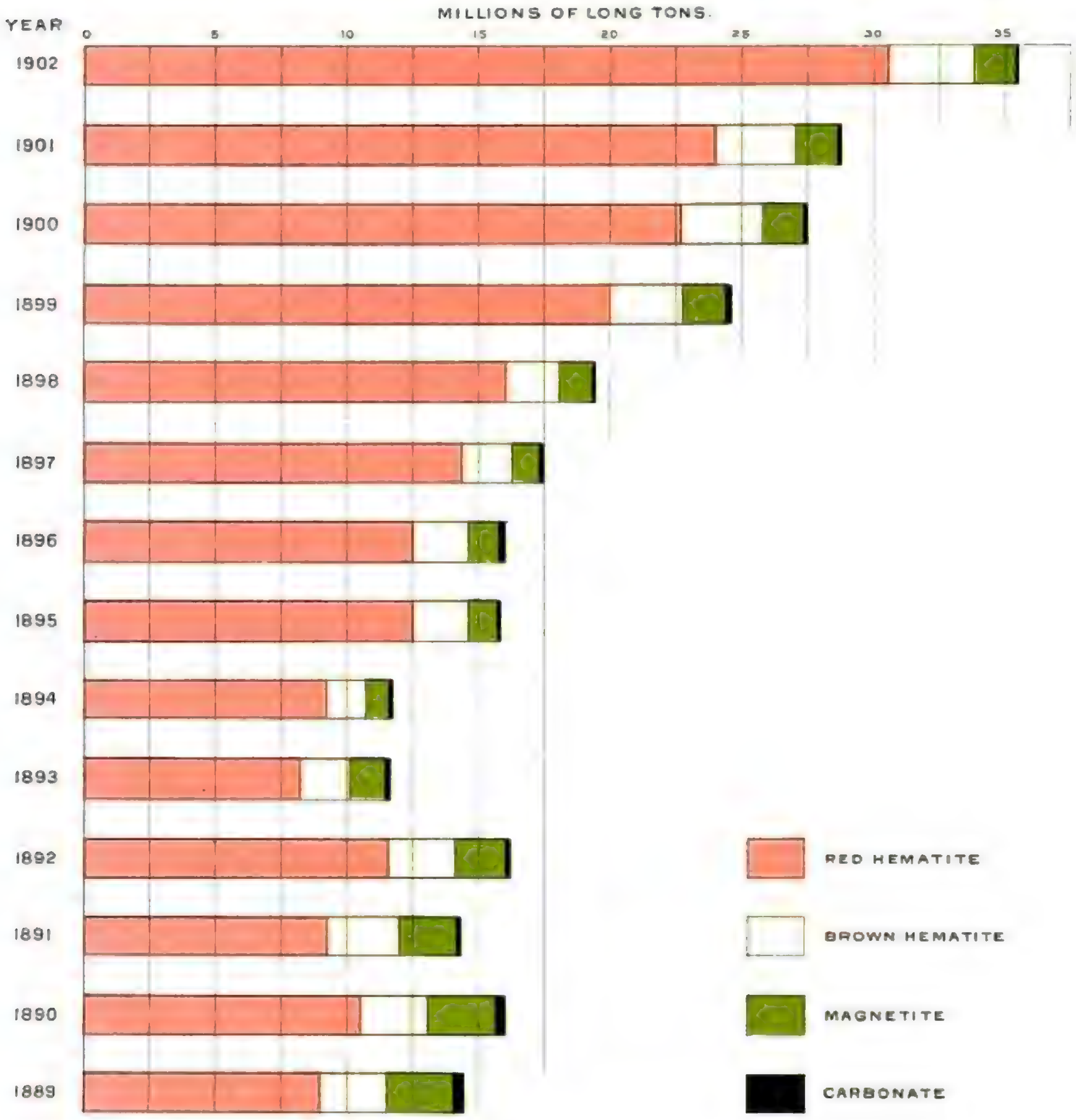
Among the methods used to beneficiate iron ores—that is, to improve their natural condition—is roasting, which may be applied for several purposes:

1. To drive off moisture.
2. While driving off moisture, to bake so as to separate the earthy matter which adheres to some ores and which often carries a large proportion of silica.
3. To eliminate carbonic acid, as in the case of the treatment of carbonate ores, thereby practically converting carbonate into brown hematite.
4. To reduce the percentage of sulphur carried in many ores, particularly magnetites.
5. To break up dense ores or make changes in the degree of oxidation and thus increase their reducibility.

Roasting was formerly done entirely in open heaps, formed of layers of wood (in some cases charcoal or fine bituminous coal supplementing the wood), alternating with layers of ore. These piles, when fire was applied to them, burned for months, and, in fact, the pile after being completed at one end was extended, while the end first finished was being roasted and the roasted ore taken from it to the furnace. An improvement in roasting was the introduction of cylindrical or rectangular masonry or metal kilns, in which fuel is mixed with the ore. In this way a more economical handling of the material is possible, and the results are under better control. In later years improvements in the roasting of ore have been practically confined to feeding kilns with gas, derived directly from the gas furnaces or obtained from gas producers. In the drying of brown hematites advanced progress is illustrated at the Shelby Iron Works, Alabama, where the Davis-Colby kiln using gas, roasts brown hematite ores. A statement by Mr. Charles J. Christian shows that taking green ore as it came from the washer, the yield was 43 per cent, and to flux this ore 23 per cent of limestone was required, while to smelt it 135 bushels of charcoal were necessary. When roasted in heaps, the moisture driven off, and the reduction of silica, which was obtained by screening, showed a yield of 50 per cent of iron, the requirements for smelting being 20 per cent of limestone and 105 bushels of charcoal. When gas kilns were introduced the yield of the ore was increased to 52 per cent, the proportion of flux was reduced to 18 per cent and the fuel consumption to 102 bushels of charcoal.

An experiment was also made in taking from a stock pile ore which had been roasted in heaps and reroast-

DIAGRAM I.– CLASSIFICATION OF IRON ORE PRODUCTION: 1889 TO 1902.



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ing it. When the yield was increased to 56 per cent, the flux was reduced to 15 per cent of the ore burden, and the fuel consumption fell to 95 bushels of charcoal per ton of iron. In ordinary practice, Mr. Christian states, that the shrinkage of ore due to roasting and screening is about 23 per cent, water to the extent of 15 to 18 per cent being driven off; the balance is tailings in which there is some iron, but this loss is more than compensated for by the reduction in silica. The richer ore not only requires less flux and fuel, but also increases the product from a given furnace and reduces the cost of production correspondingly.

In roasting for the elimination of carbonic acid, most of the ores have been treated in piles, although some have been subjected to the roasting process in large kilns, some of these being 16 feet in diameter and 60 feet high; it is probable, however, that better results would be obtained in lower kilns. This treatment of the roasted ore is primarily to convert the carbonate into sesquioxide of iron by driving off the carbonic acid gas, and practically converting the clay ironstone ore into a brown hematite ore.

A number of years ago efforts were made in Scotland to use the upper portion of a blast furnace for this purpose, and one plant was erected in this country, the expectation being not only to drive off the carbonic acid gas from the ore, but to coke the raw coal as it passed down the furnace. This departure need not be further considered, as practically all the roasting is now done prior to feeding the ore to the furnace, and the results obtained encourage the continuance of this practice.

When sulphur is to be eliminated, the old practice of feeding solid fuel with the ore to heaps or kilns is less perfect than the new, as in the newer kilns using gas the ore is maintained at a high temperature, so as to oxidize more of the sulphur than would otherwise be the case. The most extensive use of ore roasting kilns is in the neighborhood of the Cornwall ore mines, Pennsylvania, where the average amount of sulphur in the ore as mined is 2.5 per cent. In kilns operated by fuel fed in alternate layers with the ore the sulphur is reduced about one-half; but in the kilns where gas is applied and the incandescent ore subsequently subjected to currents of air, the percentage of sulphur is reduced below 1 per cent. In addition to reducing the sulphur, the ore is improved in texture, and results obtained at the Wharton furnace in New Jersey show a very decided improvement independent of the elimination of sulphur. The roasting undoubtedly affects the physical character of the ore, making it more porous; it is, therefore, more readily attacked by the blast furnace gases. Where a component is to be eliminated in whole or in part, the driving off of this, whether it be water, carbonic acid, or sulphur, affects the texture of the mineral and makes it more readily reducible. It may be that the combined water in a magnetic ore, or the proportion which is hygroscopic, removed in the process of roasting, improves the texture of the ore; but this is not a matter upon which enough experiment has been made to speak with definiteness.

Mr. Edward Kelly, manager of the Wharton blast furnaces in New Jersey, states that the base of the ore mixture used in these furnaces is Hibernia magnetic ore, a close grained refractory ore, which is roasted to secure lower fuel consumption than is necessary when using it in the raw state. One furnace using 75 per cent Hibernia roasted ore, 12.5 per cent Hibernia raw ore, and 12.5 per cent soft Lake Superior hematite (the yield of this mixture approximating 50 per cent of iron) produced a ton of pig iron on a fuel consumption of 2,050 pounds. Another furnace, using 75 per cent Hibernia unroasted ore and 25 per cent of hematites, required 2,500 pounds of fuel to make 1 ton of metal. Therefore, the apparent saving at the furnace using Hibernia ore roasted is 450 pounds of fuel per ton of metal. With fuel at $4 per ton, this represents a saving of 90 cents per ton of pig iron, which the management attributed entirely to the roasting of Hibernia ore.

It may be considered as an established principle that whenever the metallic yield of an ore can be improved and the cinder making constituents reduced and yet left in sufficient quantity to permit satisfactory smelting, such a treatment is more economically done before charging the ore into the furnace than after it reaches the tunnel head, and it may be asserted that the beneficiating of ores in a blast furnace is the most expensive method to follow.

To determine the results to be obtained from roasting an iron ore a practical demonstration is essential. A laboratory test will be of value, but not nearly so satisfactory as a practical trial in a blast furnace. However, as such a trial is expensive, the laboratory experiment must be relied upon where there is no roasting appliance. Thus, by taking a sample of unroasted ore, crushing it fine, and similarly treating a sample of the same ore roasted, exposing this in tubes to the action of furnace gases, or of a current of carbon monoxide gas at a low red heat, the amount of oxygen in each case removed could be compared. Such a test would indicate whether a saving in fuel to offset the expense of roasting is probable. Blast furnaces using raw Lake Champlain magnetic ores require from 2,600 to 2,800 pounds of fuel per ton of metal, and in similar furnaces using Lake Superior ores 2,000 to 2,200 pounds per ton are required. With coke at $2.25 per ton the fuel saving of 600 pounds represents a decreased cost of 67.5 cents per ton of pig iron. When magnetites are roasted the smelting conditions approximate those prevailing with red hematites.

Another feature which has attracted attention in the Lake Superior region is the amount of moisture in the ore, and the proposition has been made to experiment on a large scale with the idea of reducing this, as it limits the yield of the ore in the furnace and means additional freight by vessels to the lower lake and from the receiving docks to the blast furnaces.

ADVANTAGES OF MIXING IRON ORES.

The circumstances surrounding the mining, handling, and transporting of ores from the Lake Superior iron region seem to have a decidedly beneficial influence in securing the delivery to the blast furnaces of ores of nearly uniform composition. Similar conditions prevail elsewhere, but not to the same extent as in the Lake Superior region, because of the size of the deposits in that district, their liberal exploitation, their distance from points of consumption, and climatic conditions which limit the water transportation of ores.

All iron deposits vary more or less in different portions. This variation may be in the percentage of iron, silica, phosphorus, or other ingredients, and where a furnace depends on local mines, drawing upon them from day to day, receiving its stock practically as mined, greater irregularities are to be expected in the ore delivered than where ore passes through various handlings.

In the Lake Superior region the practice of the larger mines, although the mineral may nominally be of uniform character, is to win ore from several portions of the deposit simultaneously. The ores so won may be mixed in trains going to the ore docks, or trains may be made up entirely of ore from certain portions of the mines. Unless the chemical composition of this ore varies notably in the percentages of iron and phosphorus no segregation is necessary, and a number of bins in the shipping dock are filled with ore as it comes down in the railroad trains. A vessel brought to the side of the dock receives ore simultaneously, or nearly so, from a number of alternate pocket spouts, and is then moved to intermediate spouts. As the bins or pockets hold several carloads each there is a mixture in these and a further mixture in the hold of the vessel.

When the vessel reaches the receiving dock the ore is taken out by mechanical appliances, seldom by hand, the buckets delivering the ore either to stock piles on the receiving docks or directly into cars which convey it to the blast furnace.

As the shipping season on the Great Lakes covers usually about seven months in each year the blast furnaces must either carry stocks of ore at the plants or have them held at the receiving docks. Such accumulations of stocks result in securing a general mixture of ores from each mine which supplies the plant. Where work is prosecuted in the winter in the Lake Superior region, it is confined principally to dead work or exploration, largely to opening up drifts or chambers to facilitate mining during the next season. This ore taken out in the winter becomes thoroughly mixed in the stock pile and is subject to the same handling as above described. Even if the ore is delivered from vessels directly to cars, and these cars are dumped into the bins at the blast furnace, there is the admixture of ore from different parts of the mine, resulting from handling at the shipping and receiving docks, a mixture which it is not possible to secure from ores which are mined and sent directly to the furnace. The result is that the Lake Superior ores from different mines naturally have greater uniformity than those from other sections which may have ores of equal desirability. This may seem an unimportant matter when the average of the ores charged determine the basis on which to use them, but it exerts an effect on the operation of the furnace because there may be constant changes which affect the fluxing. For if at one time of a day the ore is low in silica, and at another time comparatively high, although the ore comes from the same bin, the fluxing will not be as perfectly equated as desired. As a consequence, the interior lining of a blast furnace is attacked, or the pig iron produced is more irregular than if the same relation between the gangue material in the ore and the fluxing medium was maintained steadily.

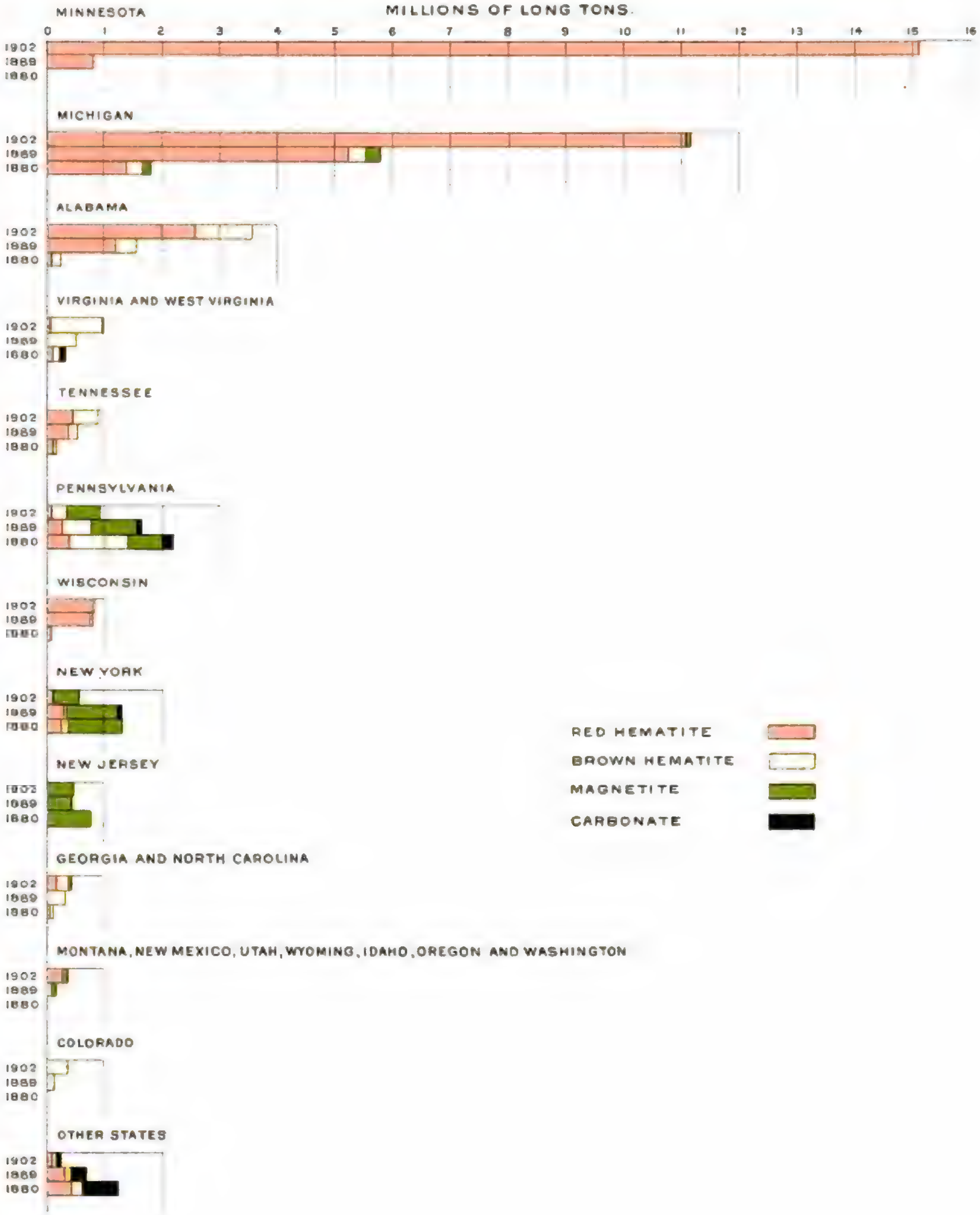
CLASSIFICATION OF IRON ORE PRODUCTION.

The rapid growth in production, both absolutely and proportionately, of red hematite in the United States is illustrated by Diagram I, which shows proportionately the quantity of red hematite, brown hematite, magnetite, and carbonate iron ores produced in 1889 (the classification being that of the Eleventh Census), and from 1890 to 1902, inclusive. While there has been a decided increase in red hematite, there has also been an advance, absolutely but not proportionately, in brown hematite, and a decline in the proportion of magnetite, although in late years this has been nearly stationary. The quantity of carbonate ore has constantly decreased.

Diagram II gives the relative quantities of each class of ore supplied by the more important producing states for the three census years 1880, 1889, and 1902. The illustration does not embrace the states producing small quantities. Even if the year 1900 had been selected for the comparison, the growth over 1889 would have been shown to be almost as great as that of 1889 over 1880. The increase of 1902 over 1889 is greater.

The plate shows that the entire production of Minnesota, and nearly all of the output of Alabama, Michigan, and Wisconsin, is classed as red hematite. It also shows the advance made in thirteen years, which is most notable in Alabama, Michigan, and Minnesota. The majority of the brown hematites are indicated as being mined in Alabama, Colorado, Georgia, Pennsylvania, Tennessee, and the Virginias, while the magnetites come principally from New Jersey, New York, and Pennsylvania. The production has

DIAGRAM II.– PRODUCTION OF IRON ORES IN THE UNITED STATES: 1902, 1889, AND 1880.



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declined in New Jersey, New York, Pennsylvania, and in the group of states which includes "all others" not specially designated. Necessarily where the quantity of any one kind of ore has been too small to be shown on the plate it has been omitted. The legend of colors and the system of single and double cross hatching illustrate the different varieties of ores for the three census years covered by the diagram.

PRODUCTION OF IRON ORE IN LARGE MINES.

The proportion of the output of the United States contributed by large mines is a matter to which attention has been drawn, and Diagram III is presented to illustrate this. Data are not at hand showing the number of large mines and their total output, except for the years beginning with 1892, but the total production is given for the census years 1850, 1860, 1870, 1880, and 1889. The full lines of the column illustrate the total production of the ore, while the shaded portions show the quantity contributed by mines supplying over 50,000 tons. The total number of the larger mines in each year since 1891 appears in numerals at the sides of the respective columns. This showing demonstrates that while there has been an increase in the output of the smaller mines the bulk of the augmented product is due to the larger mines.

CONTEMPORANEOUS PRODUCTION OF IRON ORE IN THE UNITED STATES, GREAT BRITAIN, AND GERMANY.

Diagram IV shows for the years 1889 to 1902, inclusive, the relative quantities of iron ore produced in Great Britain, Germany, and the United States, and the proportion of the production of the United States supplied by the Lake Superior region. It will be noted that with the exception of 1894 the United States was a larger producer than either Great Britain or Germany. The strides by which these competitors have been distanced is illustrated by the showing for the interval from 1896 to 1902. A varying and practically decreasing tendency of the iron ore trade is illustrated for Great Britain, while a general advance is shown for Germany. The plate indicates the relation to the iron ore industry of the United States borne by the production of the Lake Superior region, which, since 1899, has been greater than the annual output of the mines of Great Britain, and since 1900 considerably in advance of the total product of the German mines.

DIAGRAM III.—ANNUAL PRODUCTION OF IRON ORE IN THE UNITED STATES.

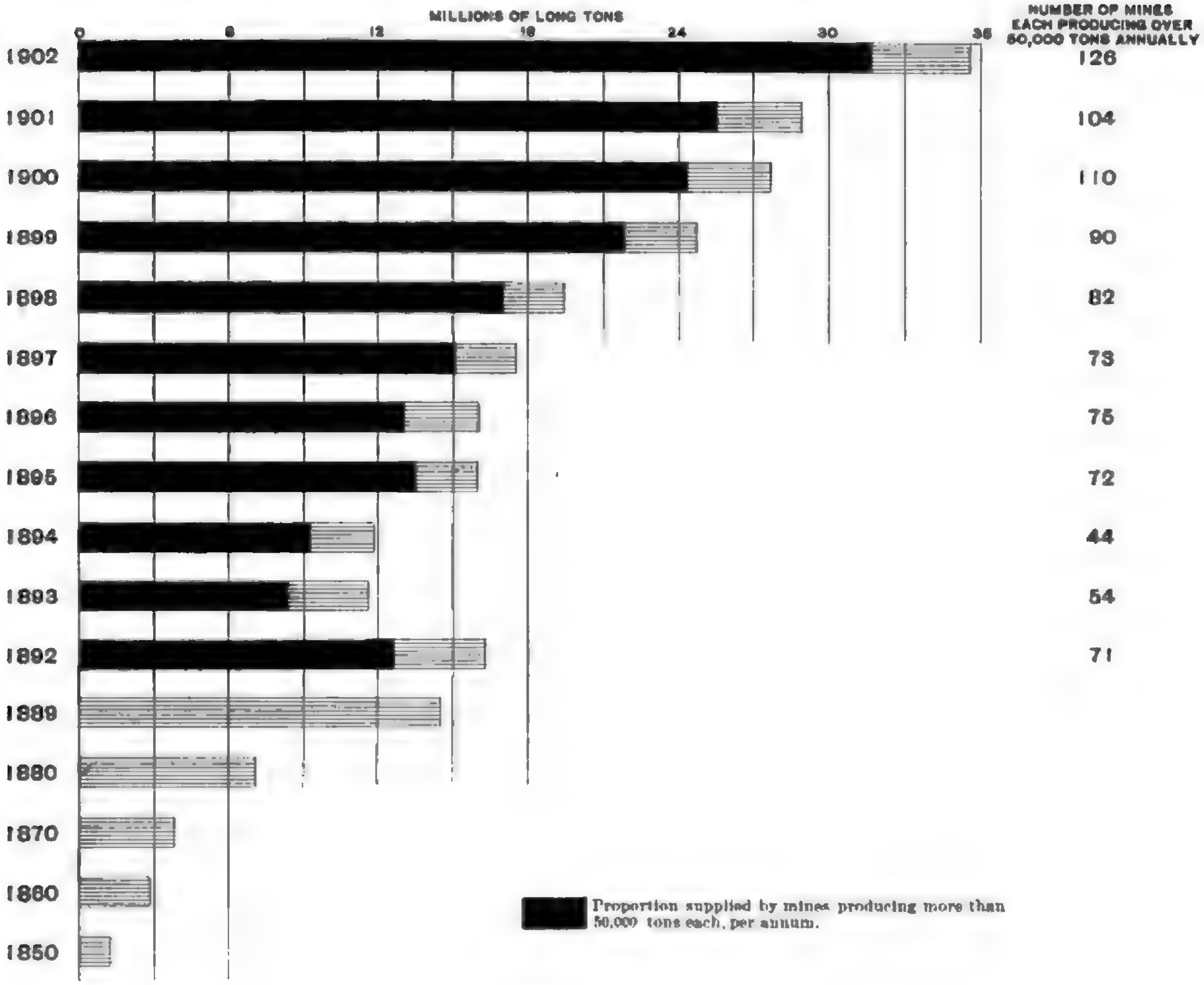

DIAGRAM IV.—CONTEMPORANEOUS PRODUCTION OF IRON ORES IN THE UNITED STATES, GREAT BRITAIN, AND GERMANY; ALSO RELATIVE PROPORTION SUPPLIED FROM THE LAKE SUPERIOR REGION: 1889 TO 1902.

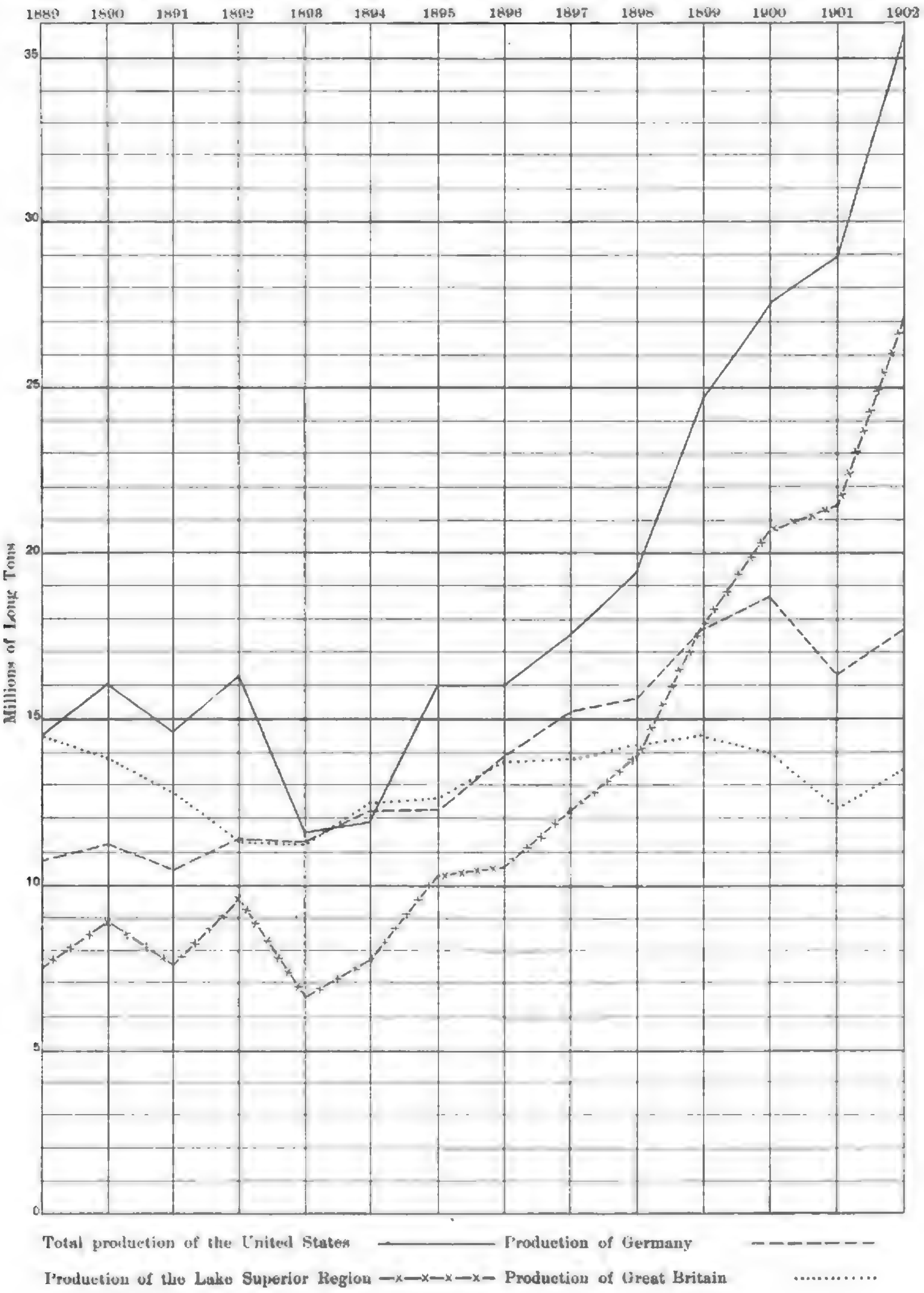

TABLE 14.—DETAILED

		United States.	Alabama.	Colorado.	Georgia.	Maryland.	Michigan.
1	Number of mines	525	59	33	19	29	80
2	Number of operators	332	31	20	13	28	41
	Character of organization:						
3	Individual	83	3	1	3	25	
4	Firm	33	1	1	1	2	
5	Incorporated company	214	27	18	9	1	41
6	Cooperative association	2					
	Salaried officials, clerks, etc.:						
7	Total number	2,405	227	33	60	5	750
8	Total salaries	$2,113,230	$188,141	$42,577	$42,361	$1,910	$775,914
	General officers—						
9	Number	129	11	5	9	1	33
10	Salaries	$298,076	$35,100	$6,550	$13,855	$600	$102,237
	Superintendents, managers, foremen, surveyors, etc.—						
11	Number	846	107	9	30	3	195
12	Salaries	$797,807	$91,351	$14,600	$17,728	$910	$256,157
	Foremen below ground—						
13	Number	782	26	10	8		307
14	Salaries	$627,178	$18,540	$14,297	$4,118		$274,098
	Clerks—						
15	Number	648	83	9	13	1	215
16	Salaries	$390,169	$43,150	$7,130	$6,660	$400	$143,422
	Wage-earners:						
17	Aggregate average number	38,851	4,864	418	688	76	14,456
18	Aggregate wages	$21,531,792	$2,029,807	$417,162	$229,138	$22,349	$9,132,763
	Above ground—						
19	Total average number	15,769	3,133	56	536	76	3,494
20	Total wages	$7,444,435	$1,213,629	$61,189	$170,318	$22,349	$2,075,167
	Engineers, firemen, and other mechanics—						
21	Average number	3,756	364	30	59	5	1,401
22	Wages	$2,309,527	$182,305	$35,413	$27,327	$1,955	$912,013
	Miners—						
23	Average number	4,813	1,417		365	59	39
24	Wages	$1,781,983	$570,526		$112,357	$18,249	$23,185
	Boys under 16 years—						
25	Average number	469	116		35	12	2
26	Wages	$77,265	$18,376		$4,712	$2,145	$407
	All other wage-earners—						
27	Average number	6,731	1,236	26	77		2,052
28	Wages	$3,275,660	$442,422	$25,776	$25,922		$1,139,562
	Below ground—						
29	Total average number	23,082	1,731	362	152		10,962
30	Total wages	$14,087,357	$816,178	$355,973	$58,820		$7,057,596
	Miners—						
31	Average number	13,743	1,110	282	106		6,217
32	Wages	$8,868,687	$577,989	$287,428	$43,446		$4,252,230
	Miners' helpers—						
33	Average number	2,293	355	53	28		1,005
34	Wages	$1,252,772	$136,210	$35,647	$10,545		$630,919
	Boys under 16 years—						
35	Average number	49	10		6		8
36	Wages	$11,709	$2,000		$1,080		$3,086
	All other wage-earners—						
37	Average number	6,997	256	27	12		3,732
38	Wages	$3,954,189	$99,979	$32,898	$3,749		$2,171,361
	Average number of wage-earners at specified daily rates of pay:						
	Engineers—						
39	$1.00 to $1.24	21	1		1	1	
40	$1.25 to $1.49	91	13		7	1	
41	$1.50 to $1.74	168	61		3	1	
42	$1.75 to $1.99	239	10		5		111
43	$2.00 to $2.24	378	16		8		219
44	$2.25 to $2.49	84	4		1		16
45	$2.50 to $2.74	23	2				4
46	$2.75 to $2.99	7	1				1
47	$3.00 to $3.24	25	1	2			1
48	$3.25 to $3.49	9					
49	$3.50 to $3.74	17		4			
50	$3.75 to $3.99	1					
51	$4.00 to $4.24	10		9			
52	$4.25 and over	29					
	Firemen—						
53	$0.50 to $0.74	1					
54	$0.75 to $0.99	3			1		
55	$1.00 to $1.24	49	7		4	1	
56	$1.25 to $1.49	125	55		6		
57	$1.50 to $1.74	70	8		1		8
58	$1.75 to $1.99	312					225
59	$2.00 to $2.24	183			5		70
60	$2.25 to $2.49	37					1
61	$2.50 to $2.74	9		2			
62	$3.00 to $3.24	3					
63	$3.25 to $3.49	2					
64	$3.50 to $3.74	2		2			
	Machinists, blacksmiths, carpenters, and other mechanics—						
65	$0.75 to $0.99	3					
66	$1.00 to $1.24	36	14		1		2
67	$1.25 to $1.49	108	22		5	1	9
68	$1.50 to $1.74	206	70		3		45
69	$1.75 to $1.99	341	24		1		152
70	$2.00 to $2.24	502	51		5		235
71	$2.25 to $2.49	290	1				168
72	$2.50 to $2.74	186	16		1		73
73	$2.75 to $2.99	63					21
74	$3.00 to $3.24	52	4	1	1		17
75	$3.25 to $3.49	12		2			3
76	$3.50 to $3.74	27		2			12
77	$3.75 to $3.99	2					1
78	$4.00 to $4.24	10		4			4
79	$4.25 and over	4		2			2

SUMMARY: 1902.

Minnesota.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	Wisconsin.	All other states and territories.[1]	
59	34	15	15	12	47	22	62	16	23	1
31	27	9	13	9	42	13	25	10	20	2
	12	2	2	2	20	4	2	2	5	3
	9		1	2	9		5	1	1	4
31	5	7	10	5	12	9	18	7	14	5
	1				1					6
529	15	138	62	5	91	106	257	83	44	7
$430,994	$14,766	$101,870	$65,231	$2,037	$74,788	$71,835	$174,034	$85,262	$41,510	8
24	5	8	5		9	7	8	2	2	9
$34,378	$9,500	$16,770	$14,750		$19,500	$9,200	$29,200	$4,036	$2,400	10
189	8	21	17	1	54	60	146	23	33	11
$134,979	$4,705	$19,457	$25,336	$770	$41,353	$37,848	$87,184	$21,971	$33,460	12
200	1	90	29	1	15	14	44	34	3	13
$172,827	$240	$53,100	$18,485	$257	$6,848	$10,084	$22,262	$29,975	$2,047	14
166	1	19	11	3	13	25	59	24	6	15
$88,810	$321	$12,543	$6,660	$1,010	$7,087	$14,405	$35,388	$19,290	$3,003	16
8,256	148	1,660	965	111	1,140	1,299	2,686	1,361	723	17
$5,376,983	$57,175	$773,296	$432,039	$38,901	$436,307	$512,702	$888,908	$837,661	$346,411	18
2,668	147	696	352	24	873	845	2,002	394	543	19
$1,656,501	$56,675	$277,622	$162,258	$10,661	$329,450	$276,937	$641,286	$216,118	$274,375	20
834	11	212	148	2	121	132	219	153	65	21
$580,891	$6,850	$117,792	$77,190	$900	$65,759	$63,709	$96,987	$98,462	$41,974	22
103	54		72	22	480	398	1,113	62	329	23
$59,820	$20,155		$24,541	$9,761	$180,290	$128,399	$447,518	$33,832	$153,350	24
2	1	5	2		21	90	176	4	3	25
$443	$170	$1,074	$450		$2,806	$16,509	$29,351	$600	$222	26
1,729	81	119	139		251	225	194	165	146	27
$1,015,347	$29,500	$158,656	$60,077		$90,595	$68,320	$67,430	$83,224	$78,829	28
5,508	1	1,024	633	87	267	454	684	977	190	29
$3,720,432	$800	$495,764	$209,781	$28,240	$106,757	$235,765	$247,672	$621,543	$72,036	30
3,463	1	261	365	80	152	326	640	645	95	31
$2,432,487	$800	$133,156	$170,691	$25,900	$61,679	$177,039	$236,040	$421,929	$47,873	32
393		206	54		80	85	8	8	12	33
$233,192		$95,143	$25,058		$33,365	$43,006	$2,272	$4,171	$2,884	34
					1	4	17	3		35
					$106	$900	$2,870	$1,667		36
1,752		557	194	7	28	39	19	321	73	37
$1,054,763		$267,465	$74,052	$2,340	$11,607	$14,730	$6,490	$193,476	$21,279	38
			10		4		2		2	39
1	1	3	8		25	8	23		1	40
1		30	11		14	18	22		7	41
13	2	42	14	1	1	5	4	29	2	42
82	1	4	9		6	13	6	11		43
52					2	3	5		1	44
9			1		2		5			45
			1		3		1			46
19						2				47
9										48
13										49
1										50
1										51
27									2	52
							1			53
							2			54
			1		1	9	24		2	55
		3	28		10	13	19		3	56
1	1	29			7	9	9		3	57
47		14	4					22		58
86			2		5			15		59
31									2	60
5						1			1	61
3										62
									2	63
										64
							1		2	65
		2	3		4		8		2	66
2	1	13	8		3	11	25	1	7	67
6		16	19	1	5	26	31	3	1	68
78		40	5		5	5	9	29	3	69
130	4	9	13		7	7	19	14	7	70
82		13	4		3	1	1	16	1	71
78	1	4	4				1	6	2	72
22			2		11			3	1	73
21			2			1	1		4	74
6									1	75
7									6	76
								1		77
1			1							78
										79

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[1] Includes operators distributed as follows: Connecticut, 1 (2 mines); Kentucky, 3; Massachusetts, 1; Montana, 3; New Mexico, 1 (2 mines); North Carolina, 3; Texas, 1 (2 mines); Utah, 4; Vermont, 1; West Virginia, 1; Wyoming, 1.

TABLE 14.—DETAILED

		United States.	Alabama.	Colorado.	Georgia.	Maryland.	Michigan.
	Average number of wage-earners at specified daily rates of pay—Con.						
	Miners—						
80	$0.50 to $0.74	13					
81	$0.75 to $0.99	296	80		28	3	
82	$1.00 to $1.24	3,001	372		297	53	
83	$1.25 to $1.49	1,057	167		61	2	
84	$1.50 to $1.74	2,478	1,068		72	1	463
85	$1.75 to $1.99	1,585	762				126
86	$2.00 to $2.24	3,926	88				2,056
87	$2.25 to $2.49	3,642		2			2,516
88	$2.50 to $2.74	1,687		20			907
89	$2.75 to $2.99	481		14			135
90	$3.00 to $3.24	304		228			40
91	$3.25 to $3.49	24		14			8
92	$3.50 to $3.74	55					5
93	$3.75 to $3.99	2					
94	$4.25 and over	5		4			
	Miners' helpers—						
95	$0.75 to $0.99	13					
96	$1.00 to $1.24	151	108		13		
97	$1.25 to $1.49	194	77		15		
98	$1.50 to $1.74	503	170				2
99	$1.75 to $1.99	618					364
100	$2.00 to $2.24	645					525
101	$2.25 to $2.49	105					102
102	$2.50 to $2.74	38		37			1
103	$2.75 to $2.99	10					10
104	$3.00 to $3.24	16		16			
	Timbermen and track layers—						
105	$0.75 to $0.99	5	5				
106	$1.00 to $1.24	29	14		3		
107	$1.25 to $1.49	86	52				
108	$1.50 to $1.74	121	49				9
109	$1.75 to $1.99	667	1				411
110	$2.00 to $2.24	607	10				129
111	$2.25 to $2.49	245					147
112	$2.50 to $2.74	317	5				295
113	$2.75 to $2.99	4					
114	$3.00 to $3.24	2					
115	$3.25 to $3.49	2					1
116	$3.50 to $3.74	14		14			
	Boys under 16 years—						
117	Less than $0.50	141	21		11		
118	$0.50 to $0.74	250	87		30	12	1
119	$0.75 to $0.99	99	18				
120	$1.00 to $1.24	17					1
121	$1.25 to $1.49	8					8
122	$1.50 to $1.74	3					
	All other wage-earners—						
123	$0.50 to $0.74	15					
124	$0.75 to $0.99	434	106		3		12
125	$1.00 to $1.24	1,314	723		64		47
126	$1.25 to $1.49	1,195	357				131
127	$1.50 to $1.74	1,913	108		18		1,095
128	$1.75 to $1.99	3,582	61				2,225
129	$2.00 to $2.24	2,294	1				899
130	$2.25 to $2.49	459					203
131	$2.50 to $2.74	251		15	1		141
132	$2.75 to $2.99	65					17
133	$3.00 to $3.24	52		15			16
134	$3.25 to $3.49	28					1
135	$3.50 to $3.74	10		8			1
136	$3.75 to $3.99	2					1
137	$4.00 to $4.24	10		1			8
138	$4.25 and over	5					
	Average number of wage-earners during each month:						
	Men 16 years and over—						
139	January	33,854	4,358	437	562	30	13,415
140	February	33,195	4,403	428	559	30	12,858
141	March	34,714	4,616	425	644	30	13,373
142	April	36,829	4,655	433	659	75	13,946
143	May	39,291	4,693	409	670	83	14,803
144	June	39,311	4,715	413	673	47	14,899
145	July	40,594	4,850	430	661	92	14,977
146	August	41,426	4,987	406	664	85	15,340
147	September	41,259	4,861	412	647	88	15,441
148	October	40,968	4,987	407	630	72	15,449
149	November	39,859	4,939	437	705	50	14,911
150	December	38,706	4,892	419	690	41	14,440
	Boys under 16 years—						
151	January	405	113		33	2	7
152	February	397	102		40	2	6
153	March	454	118		35	18	6
154	April	497	109		41	10	8
155	May	539	117		36	13	8
156	June	531	114		38	4	10
157	July	573	124		43	17	11
158	August	599	143		41	16	13
159	September	596	143		46	18	14
160	October	570	141		48	16	13
161	November	542	147		45	16	13
162	December	511	141		46	12	11
	Contract work:						
163	Amount paid	$425,292	$500				$67,382
164	Number of employees	1,079	7				96
	Miscellaneous expenses:						
165	Total	$8,257,714	$88,008	$114,540	$76,622	$12,314	$3,004,384
166	Royalties and rent of mine and mining plant	$6,503,908	$37,938	$87,094	$8,351	$2,271	$2,254,864
167	Rent of offices, taxes, insurance, interest, and all other sundries.	$1,753,806	$50,070	$27,446	$68,271	$10,043	$749,520
168	Cost of supplies and materials	$9,005,608	$592,286	$137,450	$64,982	$2,639	$3,661,194
	Product:						
169	Quantity, long tons	35,567,410	3,574,474	[1] 306,572	330,564	24,367	11,135,215
170	Value	$65,465,321	$3,936,812	[1] $1,084,424	$452,717	$46,911	$26,095,960

[1] Includes 13,275 tons of manganiferous iron ore valued at $52,371, used in the manufacture of spiegeleisen. The high average value per ton of the product in Colorado is due to the silver content, and to its availability for use as a fluxing medium when mixed with other gold and silver ores in the smelter.

SUMMARY: 1902—Continued.

Minnesota.	Missouri.	New Jersey.	New York.	Ohio	Pennsylvania.	Tennessee.	Virginia.	Wisconsin.	All other states and territories.	
							33			80
				24	23		118		15	81
1	17		70	49	213	402	1,414		113	82
1	36	10	14		192	61	468		42	83
16	2	62	401	23	180	106	54	42	118	84
367		176	81	6	16	1	5	30	45	85
1,265		2	11		5		2	452	15	86
852		11	10		3	116		130	2	87
677						38	1	29	17	88
317							3	3	9	89
34									2	90
1								1		91
33									17	92
2										93
									1	94
		1							12	95
			12		10		8			96
		31			71					97
48		151	42		5	85				98
231		23								99
111								8		100
3										101
										102
										103
										104
										105
2		6			1		1		2	106
		2			4	20	8			107
		3	25				23		12	108
94		105						58		109
420		14	1					33		110
90		1				1		6		111
12		1					1	2	1	112
4										113
1			1							114
1										115
										116
1					8	2	96		2	117
	1	3			9	44	62		1	118
			2		4	48	23	4		119
1		2			1		12			120
										121
								3		122
		3			1	1	1		3	123
		2			30	210	7		64	124
7	1	37	74	7	177	29	124	4	20	125
13	7	329	163		31		36	13	50	126
139	7	402	50		29		1	57	4	127
933		43	10		6		1	265	35	128
1,310	1	28					1	16	8	129
251								1	4	130
86								2	6	131
47									1	132
15									6	133
27										134
1										135
1										136
5								1		137
2									1	138
6,210	108	1,453	965	34	1,074	1,126	2,156	1,323	553	139
6,198	113	1,535	862	69	1,021	1,113	2,104	1,372	530	140
6,416	113	1,580	928	112	990	1,134	2,337	1,355	611	141
7,870	134	1,684	1,007	115	1,076	1,208	2,396	1,393	678	142
8,449	147	1,732	959	125	1,102	1,250	2,664	1,429	776	143
8,750	154	1,769	989	158	1,100	1,271	2,682	1,403	790	144
9,102	182	1,775	894	141	1,229	1,257	2,945	1,392	807	145
9,456	182	1,762	978	137	1,179	1,271	2,846	1,421	812	146
9,659	161	1,691	946	101	1,184	1,217	2,718	1,396	793	147
9,449	156	1,647	1,019	121	1,153	1,225	2,577	1,346	720	148
9,308	156	1,617	996	127	1,158	1,195	2,318	1,227	715	149
8,672	156	1,612	1,013	99	1,150	1,193	2,298	1,181	865	150
2		5	2		10	95	141	2	8	151
2		5	2		10	96	137	2	3	152
2		5	2		10	98	164	4	2	153
2	1	5	2		29	93	180	5	2	154
2	1	5	2		29	101	216	6	3	155
2	1	5	2		30	102	212	8	3	156
2	1	5	2		30	94	230	11	3	157
2	1	6	2		34	98	225	12	4	158
2	1	6	2		31	99	224	9	[illegible]	159
2	2	5	2		23	93	211	10	4	160
2	2	5	2		15	96	190	8	1	161
2	2	5	2		13	93	174	6	4	162
$338,244	$500	$10,770			$1,228		$6,780	$2,750	$7,188	163
723	60	115			4		53	10	23	164
$4,134,526	$3,873	$30,114	$199,567	$1,556	$61,376	$111,654	$120,568	$247,119	$51,718	165
$3,648,750	$2,538	$7,915	$12,385	$1,503	$25,343	$93,672	$93,429	$181,213	$45,612	166
$486,776	$835	$22,199	$187,202	$53	$35,033	$18,182	$27,134	$65,906	$6,136	167
$2,069,115	$26,052	$129,231	$293,930	$845	$166,422	$144,540	$201,426	$375,959	$210,067	168
15,157,650	66,306	441,879	555,321	22,657	822,932	874,542	973,301	783,906	717,642	169
$23,969,227	$106,379	$1,228,024	$1,302,967	$41,976	$1,225,453	$1,123,627	$1,652,799	$1,900,804	$716,721	170

TABLE 14.—DETAILED

		United States.	Alabama.	Colorado	Georgia.	Maryland.	Michigan.
	Power:						
171	Total horsepower	119,558	10,370	865	2,681	315	47,595
	Owned—						
	Engines—						
	Steam—						
172	Number	1,132	105	11	10	6	321
173	Horsepower	102,878	7,440	785	2,512	315	38,551
	Gas or gasoline—						
174	Number	11			2		
175	Horsepower	86			9		
	Water wheels—						
176	Number	11					7
177	Horsepower	1,010					750
	Other power—						
178	Number	260	62	1	3		86
179	Horsepower	15,444	2,930	80	160		8,294
	Rented—						
180	Steam, horsepower	140					
	Electric motors owned—						
181	Number	35					13
182	Horsepower	937					388
183	Supplied to other establishments, horsepower	140					

SUMMARY: 1902—Continued.

Minnesota	Missouri.	New Jersey	New York	Ohio	Pennsylvania.	Tennessee	Virginia	Wisconsin	All other states and territories	
25,332	535	6,684	6,015	50	4,480	2,865	4,686	5,894	1,391	171
206	10	78	38	1	87	38	87	75	23	172
23,928	525	6,584	5,820	50	3,722	1,770	4,217	5,834	1,025	173
1	1		1		1		1		1	174
10	10		10		38		6		3	175
			1				2		1	176
			100				155		5	177
39		6	2		10	26	12	6	7	178
1,254		100	85		720	1,095	308	60	358	179
140										180
13			2		2				5	181
375			1		50				120	182
140										183

MANGANESE ORE

MANGANESE ORE.

By John Birkinbine.

Although manganese occupies an important position among metals, and is necessary in the manufacture of steel, of glass, and in the chemical industry, the production in the United States is small; and in 1902 may properly be discounted to the extent of 9,000 long tons reported as mined in Montana, which was not immediately available for consumption.

Table 1 is a comparative summary of the statistics for the industry as reported for the years 1902, 1889, and 1880.

Table 1.—*Comparative summary: 1880 to 1902.*

	1902	1889	1880
Number of mines	19	(1)	(1)
Number of operators	[illegible]	(1)	6
Salaried officials, clerks, etc.:			
Number	18	(2)	10
Salaries	$9,395	(2)	(3)
Wage-earners:			
Average number	194	432	222
Wages	$74,924	$123,958	[3] $46,610
Miscellaneous expenses	$3,845	(1)	(1)
Cost of supplies and materials	$17,728	(1)	$16,164
Product:			
Quantity, long tons	16,477	24,197	[4] 11,350
Value	$177,911	$240,559	[4] $102,700

[1] Not reported.

[2] Not reported separately.

[3] Includes salaries, not separable, of 10 salaried employees.

[4] Includes 687 tons, with an estimated value of $6,765, for which statistics of wage-earners, wages, and other expenses, etc., were not obtainable.

In the year 1902 the data are given in full, but for the previous census years some details are unobtainable, and in the year 1880 there was 1 mine from which no information was secured except the production of ore and its estimated value.

Of the 19 mines reported in 1902, 3 were in California, 6 each in Georgia and Virginia, 2 in Arkansas, and 1 each in Montana and South Carolina. The entire number was controlled by 19 operators, of whom 8 were individuals; 5, firms; and 6, incorporated companies.

Capital stock of incorporated companies.—Table 2, which follows, presents the statistics of capitalization of incorporated companies.

Table 2.—*Capitalization of incorporated companies: 1902.*

	United States.	California.	Georgia.	Virginia.
Number of incorporated companies	6	1	3	2
Number reporting capitalization	4	1	1	2
Capital stock:				
Total authorized—				
Number of shares	523,280	500,000	30	23,250
Par value	$2,855,000	$500,000	$30,000	$2,325,000
Total issued—				
Number of shares	123,330	100,050	30	23,250
Par value	$2,455,050	$100,050	$30,000	$2,325,000
Common—				
Authorized—				
Number of shares	517,280	500,000	30	17,250
Par value	$2,255,000	$500,000	$30,000	$1,725,000
Issued—				
Number of shares	117,330	100,050	30	17,250
Par value	$1,855,050	$100,050	$30,000	$1,725,000
Preferred—				
Authorized—				
Number of shares	6,000			6,000
Par value	$600,000			$600,000
Issued—				
Number of shares	6,000			6,000
Par value	$600,000			$600,000

Table 2 shows that the capital stock issued amounted to $2,455,050.

In 1889 the inquiries in regard to capital were different from 1902, the capital invested in lands, buildings and fixtures, machinery, tools and implements, live stock, cash, and stock of ore on hand being asked for at that census; therefore no comparison of any value can be made. According to the reports made in 1889 the total amount of capital invested was $2,188,950, divided as follows: Land, $1,618,650; buildings and fixtures, $98,700; machinery, tools, etc., $233,750; other items, including cash, $237,850.

Employees and wages.—In Table 10 the statistics of employees and wages are presented in detail by states. The different classes of salaried officials and wage-earners are given.

Of the total amount, $84,319, reported as paid for salaries and wages in the production of manganese ore, $74,924, or 88.9 per cent, was paid to wage-earners, and $9,395, or 11.1 per cent, to the salaried officials, clerks, etc.

Table 10 shows also the average number of wage-earners at specified daily rates of pay by occupations. Miners constituted 49.5 per cent of the total number of wage-earners, and of all miners 80.2 per cent were employed at rates from $1 to $1.24 per day. This low wage rate was due to the fact that most of the employees were unskilled, and the wages paid in the Southern states were lower, as a rule, than those prevailing in the Lake Superior region, where the climatic conditions are more severe. Of the 15 engineers, 3 received $2 or more per day. Miners' helpers formed a small class, constituting 1.5 per cent of the total wage-earners. The class of "all other wage-earners" numbered 56, composed chiefly of ordinary laborers. Of these workmen 92.9 per cent received from $1 to $1.24 per day, the same general rate as that of many of the miners, while 7.1 per cent received $1.25 or more.

The average number of wage-earners, men and boys, employed during each month of the year, is also shown in Table 10. With the exception of the mines in Georgia, where employment was practically constant, the average number of wage-earners varied considerably. It will be noted that during the summer and fall months the average number of wage-earners in Virginia was considerably augmented, falling off during the winter and early spring months. In California the operations practically closed in August and remained in this condition until the end of the year.

For the various mechanical operations requiring power at the mines there were 11 steam engines of 354 horsepower.

Production.—To show the relative production of manganese ores in 1902 and in each of the nine years preceding, Table 3 is presented. It gives the production, total value, and average value per ton of ore at the mines.

TABLE 3.—*Production of manganese ores: 1893 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (long tons).	Value.	Average value per ton.
1893	7,718	$66,614	$8.63
1894	6,308	53,635	8.50
1895	9,547	71,769	7.52
1896	10,088	90,727	8.99
1897	11,108	95,505	8.60
1898	15,957	129,185	8.10
1899	9,935	82,278	8.28
1900	11,771	100,289	8.52
1901	11,995	116,722	9.73
1902	16,477	177,911	10.80

The following table shows the quantity, total value, and average value per ton of the manganese ore produced by states in the year 1902. The production of South Carolina was a sample shipment, the value of which was estimated:

TABLE 4.—*Production and value, and average value per ton, of manganese ores, by states: 1902.*

STATE.	Quantity (long tons).	Value.	Average value per ton.
United States	16,477	$177,911	$10.80
Arkansas	(1)	(1)	5.15
California	846	10,175	12.03
Georgia	3,500	20,859	5.96
Montana	(1)	(1)	13.00
South Carolina	(1)	(1)	5.00
Virginia	3,041	29,444	9.68
Arkansas, Montana, and South Carolina	9,090	117,402	....

[1] Not given separately, in order to avoid disclosing operations of individual establishments.

In producing the total for 1902, 16,477 tons, valued at $177,911, 6 states contributed, viz: Montana, Georgia, Virginia, California, Arkansas, and South Carolina, in the order named.

The following table gives the production by states for the census years 1889 and 1902, and for each of the twelve years intervening. The figures for the years between 1889 and 1902 were obtained from the statistical reports of the United States Geological Survey.

TABLE 5.—*Production of manganese ores, by states: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	United States (long tons).	Virginia (long tons).	Georgia (long tons).	Arkansas (long tons).	All other states (long tons).
Total	197,814	90,001	44,431	34,167	30,215
1889	24,197	14,616	5,208	2,528	1,845
1890	25,684	12,699	749	5,339	6,897
1891	23,416	16,248	3,575	1,650	1,943
1892	13,613	6,079	826	6,708	....
1893	7,718	4,092	724	2,020	882
1894	6,308	1,797	1,277	1,934	1,300
1895	9,547	1,715	3,856	2,991	985
1896	10,088	2,018	4,085	3,421	564
1897	11,108	3,650	3,892	3,240	326
1898	15,957	5,662	6,689	2,665	941
1899	9,935	6,228	3,089	356	262
1900	11,771	7,881	3,447	145	298
1901	11,995	4,275	1,074	92	6,554
1902	16,477	3,041	3,500	82	9,854

The output of the three states producing the greatest quantities, viz, Virginia, Georgia, and Arkansas, as well as the total for the United States, shows a marked falling off since the year 1889, when the total mined in Virginia was 14,616 long tons; in Georgia, 5,208 long tons; in Arkansas, 2,528 long tons; and in other states, 1,845 long tons; a total of 24,197 long tons, valued at $240,559.

In the year 1902 the production of manganese ore per wage-earner was greater than in either 1889 or 1880, being 85 tons, as against 56 tons in 1889 and 49 tons in 1880. But for the census year 1889 the total number of persons employed is given for the time during which the mines were operated, whereas for the census year 1902 the average number is the number that would be required at continuous employment throughout the year.

Imports of manganese ore.—The United States is the largest manufacturer of steel in the world. In the processes of the conversion of iron into steel spiegeleisen or ferromanganese obtained from manganese or manganiferous ore is a necessity. Consequently, owing to the insufficient supply of this mineral obtained in the United States, large quantities are imported.

Through the courtesy of the Bureau of Statistics of the Department of Commerce and Labor, the following table has been prepared showing the importation of manganese ore into the United States during the calendar year 1902, by countries:

TABLE 6.—*Imports of manganese ore, by countries: 1902.*

COUNTRY.	Quantity (long tons).	Value.
Total	235,576	$1,931,282
Belgium	165	1,962
Brazil	102,550	1,006,969
British East Indies	64,170	552,187
Colombia	700	7,385
Cuba	36,291	285,571
Germany	2,155	68,211
Japan	2,481	37,064
Nova Scotia, New Brunswick, etc	59	2,311
Quebec, Ontario, etc	140	820
Russia	3,338	24,581
Spain	10,164	18,098
Turkey in Europe	12,609	88,972
United Kingdom	154	10,844

Table 6 shows that in the census year 1902, 235,576 long tons were imported, valued at $1,931,282, an average of $8.20 per ton. The valuations placed on this ore are as invoiced at the point of shipment, and do not include the cost of ocean freight to the United States or rail charges to points of consumption. The principal contributor was Brazil, with a total of 102,550 long tons, valued at $1,006,969. The other contributing countries were India, Cuba, Turkey, Spain, Russia, Japan, Germany, Colombia, United Kingdom, Canada, and Belgium, in the order named.

The following table gives the quantity and value of manganese ore imported into the United States from 1889 to 1902, inclusive:

TABLE 7.—*Imports of manganese ore: 1889 to 1902.*

YEAR.	Quantity (long tons).	Value.
Total	1,436,950	$13,028,432
1889	4,286	78,491
1890	34,154	516,900
1891	28,825	380,618
1892	58,572	860,811
1893	68,113	880,238
1894	44,655	432,561
1895	86,111	717,910
1896	31,489	250,468
1897	119,961	1,023,824
1898	114,885	831,957
1899	188,349	1,584,528
1900	256,252	2,012,351
1901	165,722	1,486,578
1902	235,576	1,931,282

Table 7 shows that, with the exception of the year 1900, the largest quantity imported was in the year 1902. It will be of interest to note that in the year 1889, 24,197 long tons of domestic manganese ore were produced and 4,286 long tons of manganese ore imported; whereas, in the year 1902, 16,477 long tons of domestic manganese ore were mined and 235,576 long tons imported. In the fourteen years under consideration the manganese mines of the United States have contributed 197,814 long tons, while the importations have amounted to 1,436,950 long tons; therefore, 87.9 per cent of the manganese ore used in the United States during these fourteen years came from foreign countries. In the year 1902 the quantity of imported manganese ore represented 93.5 per cent of the total consumption. In 1902 the greater portion, 200,434 long tons, of the manganese ore brought to this country was received at the port of Baltimore, Maryland.

World's production.—As the greater portion of the manganese ore consumed in this country is obtained from foreign nations, Table 8 is presented showing the production of the more important manganese producing countries. For each country the latest reliable statistics obtainable have been used, the years to which the figures relate being indicated in the table.

TABLE 8.—*World's production of manganese ores.*

COUNTRY.	Year.	Production (long tons).	COUNTRY.	Year.	Production (long tons).
North America:			Europe—Continued.		
United States	1902	16,477	Italy	1902	2,458
Canada[1]	1902	151	Portugal	1901	5,204
Cuba[1]	1902	39,628	Russia	1900	881,300
South America:			Spain	1902	61,940
Brazil[1]	1902	156,269	Sweden	1902	2,806
Chile[1]	1901	31,477	Turkey[1]	1902	19,210
Europe:[2]			Asia:		
Austria	1902	9,507	India	1902	157,780
Bosnia and Herzegovina	1902	5,660	Japan	1901	15,858
France	1901	21,918	Java[1]	1899	1,588
Germany	1901	49,025	Oceania:		
Greece	1901	13,916	New Zealand	1901	208
Hungary	1902	7,241	Queensland	1901	218
			South Australia	1901	192

[1] Exports.

[2] Metric tons.

Russia has for years been the largest producer, the bulk of the ore coming from the Caucasus region, the mines being located in the Secharopan district of the government of Kutais, not far from the extreme eastern shore of the Black Sea, near Poti. India has important deposits which have been actively exploited in late years, most of those from which shipments are made being located in the presidency of Madras. In the year 1902 Brazil, where the manganese industry has been lately developed, took third position; most of the ore mined being obtained in the Minas Geraes and Nazareth districts, located in the states of Minas Geraes and Bahia, respectively, in the eastern central portion of the country. Spain, Turkey, Cuba, and Chile have important deposits of manganese ores, and small quantities are obtained in the Austrian Empire, France, Germany, Greece, Italy, Portugal, Sweden, Japan, Canada, New Zealand, and in Australia. Failure to appreciate the necessity of careful preparation of ores has restricted the quantities shipped from some of these countries.

In the United States the manganese deposits exploited are either of comparatively small extent, or the mineral contains phosphorus or silica in such proportions as to limit the transportation value of the ore, or the deposits are too far removed from markets where the ore would be consumed to make their development at present desirable. Manganese, however, either in the form of an ore or associated with iron or silver, has been supplied in large quantities. The bulk of this, being applied to the manufacture of steel, is sold under limitations, wherein the modicum of phosphorus and the percentage of silica, calculated on sliding scales, affect the prices paid for the ore, thus seriously interfering with the development of some properties where the quantity is apparently sufficient, but the quality is not desirable.

Value of manganese ores.—Manganese ores are valued from a sliding scale for the ore delivered f. o. b. cars at the large steel works, the prices being based on ores containing not more than 8 per cent of silica or more than one-tenth of 1 per cent of phosphorus. To illustrate, the following may be taken as the prices for manganese ores delivered in the Pittsburg (Pa.) district, they being subject to change without notice unless otherwise agreed:

Prices paid for manganese ore delivered in the Pittsburg (Pa.) district.

MANGANESE.	PRICE PER UNIT.	
	Iron (cents).	Manganese (cents).
Ore containing—		
Above 49 per cent	6	28
46 to 49 per cent	6	27
43 to 46 per cent	6	26
40 to 43 per cent	6	25
37 to 40 per cent	6	24
34 to 37 per cent	6	23
31 to 34 per cent	6	22

These prices are subject to deductions as follows: For each 1 per cent of silica in excess of 8 per cent, 15 cents per ton, and for each two-hundredths of 1 per cent of phosphorus in excess of one-tenth of 1 per cent, 1 cent per unit of manganese. Settlements are based on analyses of the ores dried at 212° F., the percentage of moisture in samples when taken being deducted from the weight.

The value of ore at the mines would be practically the price obtained for the ore delivered in the Pittsburg district, as above, less transportation charges.

In the manufacture of steel for various purposes and by different methods, the metallic manganese required ranges from about 9 to 40 pounds per ton of ingots produced, the average for the entire steel industry approximating 20 pounds of metallic manganese, or about 25 pounds of high-grade ferromanganese per ton of ingots made.

Manganiferous iron ores.—In addition to the true manganese ore produced, considerable quantities of manganiferous iron ore are obtained in the United States, the statistics of which are included in the report on iron ores. In the year 1902 there was obtained in the state of Colorado 13,275 long tons of this class of ore, in which the percentage of manganese varied from 18 to 32 per cent, having a total reported value at the mines of $52,371. This ore was all used in the production of spiegeleisen at steel works and should properly be classed as manganese ore, but owing to the impossibility of segregating the proportion of wage-earners, wages, and other expenses chargeable in the different mines from which this ore was obtained, the data were included in the statistics of iron ore. In the Lake Superior region, also, considerable amounts of iron ore are won which carry small percentages of manganese, but, as a rule, this does not exceed 1 per cent. In Virginia, too, a small quantity of manganiferous iron ore has been secured while mining true manganese ore.

The following statement shows the quantity, percentage of manganese, value at the mine, and average value per ton of manganiferous iron ores mined in the United States during the year 1902:

Production of manganiferous iron ores: 1902.

LOCALITY.	Quantity (long tons).	Per cent of manganese.	Value.	Average value per ton.
Total	901,214	1 to 32	$2,001,626	$2.22
Colorado	13,275	18 to 32	52,371	3.95
Lake Superior region	884,939	1 to 10	1,946,255	2.20
Virginia	3,000	(1)	3,000	1.00

(1) Not given.

The following table presents the production, total value at the mine, and average value per ton of the manganiferous iron ores obtained in the United States from 1889 to 1902, inclusive, the statistics for the years between the two censuses being obtained from the reports of the United States Geological Survey.

TABLE 9.—*Production of manganiferous iron ores: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (long tons).	Value.	Average value per ton.
1889	83,434	$271,680	$3.26
1890	61,863	231,655	3.74
1891	132,511	314,099	2.37
1892	153,373	354,664	2.31
1893	117,782	283,228	2.40
1894	205,488	408,597	1.99
1895	125,729	233,998	1.86
1896	338,712	726,413	2.14
1897	202,804	343,784	1.70
1898	287,810	429,302	1.49
1899	761,845	1,147,047	1.51
1900	377,577	1,037,314	2.75
1901	574,489	1,475,084	2.57
1902	901,214	2,001,626	2.22

In the year 1889 the total production of manganiferous iron ores in the United States was 83,434 long tons, valued at $271,680. In 1902 the production was 901,214 long tons, an increase of 817,780 long tons, or nearly tenfold.

Argentiferous manganiferous iron ores.—In the state of Colorado argentiferous manganiferous iron ore is obtained from precious metal mines. This ore, containing an insufficient quantity of silver to make it valuable on that account, finds a ready market as a flux for use in smelters. The ores which are mined chiefly in the vicinity of Leadville, Colo., are classed usually as carbonates, sulphides, oxides, and siliceous ores. The first two classes are dependent for their value upon the carbonates and sulphides of lead and silver, but the oxides and siliceous ores may or may not be dependent on the precious metal content, and unless the value of the ores for smelting purposes was greater than the charge for the extraction of the precious metal (approximating $12 per ton) they have been considered as iron ores and included in the report on that mineral. The total quantity of these ores (which contain varying percentages of manganese) mined in the year 1902 was 194,132 long tons, valued at $908,098, an average of $4.68 per ton. In 1889, 64,987 long tons of argentiferous manganiferous ores valued at $227,455, were mined in the United States, the average value being $3.50 per ton. This shows an increase in 1902 of 129,145 tons, or nearly twofold, while the average value per ton rose to $4.68.

Manganiferous zinc ores.—The franklinite mines, located in northern New Jersey, produce ores which carry, in addition to the zinc content, iron and manganese. The clinker resulting from treatment for the removal of zinc is utilized in the production of spiegeleisen. The quantity of this class of material produced in 1902 was 65,246 long tons, valued nominally at $1 per ton. The production in 1889 was 43,648 long tons, valued at $54,560, or an average value of $1.25 per ton.

A résumé of the useful minerals produced in the United States in 1902, which contained manganese in notable proportions, is given in the following statement, in which the figures for the year 1889 have been included for purposes of comparison:

Useful minerals produced containing manganese in notable proportions: 1902 and 1889.

	1902			1889		
	Quantity (long tons).	Value.	Average value per ton.	Quantity (long tons).	Value.	Average value per ton.
Total	1,177,069	$3,152,881	$2.68	216,266	$794,254	$3.67
Manganese ores	16,477	177,911	10.80	24,197	240,559	9.94
Manganiferous iron ores	901,214	2,001,626	2.22	83,434	271,680	3.26
Manganiferous silver ores	194,132	908,098	4.68	64,987	227,455	3.50
Manganiferous zinc residuum	65,246	65,246	1.00	43,648	54,560	1.25

The total quantity of manganese and manganiferous ores mined in the United States in 1889 was 216,266 long tons, valued at $794,254, whereas in 1902 it had risen to 1,177,069 long tons, valued at $3,152,881, the increase being confined entirely to manganiferous ores, the production of true manganese ores having decreased.

REVIEW OF THE INDUSTRY BY STATES.

The conditions surrounding and affecting the production of manganese ores in different states are summarized as follows:

Arkansas.—Manganese ores occur chiefly in two districts of Arkansas—(a) the Batesville district, in Independence and Izard counties, in the northeastern part of the state; and (b) in the southwestern section, extending from Pulaski county on the east to Pope county and Indian Territory on the west. The mining in the latter district has been limited and practically all of the ores mined have come from the Batesville region, where they occur in residuary clays, derived from the decay of limestone.

Ore was discovered near Batesville about 1840, and in 1850 small quantities were sent to Boston, New York, Philadelphia, and Chicago. The maximum output was in the year 1892, when 6,708 long tons were produced. Lately, however, there has been a marked decline, for although some of the ores of Arkansas carry satisfactory percentages of manganese, their high phosphorus content, in addition to the distances from points of consumption and the expense of mining, has rendered the winning of many of them unprofitable.

In 1902, 82 tons of manganese ore were secured. According to the Eleventh Census the amount of manganese ore mined in Arkansas in 1889 was 2,528 tons. The total production of the district from 1850 to 1902, inclusive—some of the figures being estimates—was 49,974 tons.

California.—California contains a number of deposits of manganese ore, some of which are reported as of high quality, and have been largely employed in chlorination works for the reduction of gold ores. In 1902 deposits in Alameda, San Joaquin, Santa Clara, and Stanislaus counties were operated, the amount produced being 846 tons. The quantity mined in 1889 was 53 tons. The total production of manganese ore in California from 1874 to 1902, inclusive, as near as can be ascertained, amounts to 11,358 tons, the production in 1902 being the maximum.

Colorado.—A large amount of iron ore, which contains a mixture of iron, manganese, and the precious metals, is produced in Colorado. The greater portion of this ore, which carries an insufficient amount of the precious metals to make it valuable on that account, is used as a flux in smelters, while some of that which is higher in manganese content is forwarded to steel works, where it is utilized in the manufacture of spiegeleisen. The figures for the production of these classes of ores, which have been included in the census report on iron ores, are inserted here as an item of interest. The comparison of the production in the year 1902 with that of the census year 1889 is shown in the following statement:

Production of manganiferous ores in Colorado: 1902 and 1889.

ORE.	1902 (long tons).	1889 (long tons).
Total	207,407	67,162
Manganiferous iron ores used for producing spiegeleisen	13,275	2,075
Manganiferous silver ores	194,132	65,087

Georgia.—The manganese ores of Georgia are won from two districts—the Cartersville district, located near the town of that name in Bartow county, and the Cave Springs district, in Floyd and Polk counties. The deposits in the latter district have been but little worked, nearly the entire production coming from the Cartersville district. The mines which were active in the year 1902 were all located there. Some of these manganese ores are of good quality, but others contain comparatively high percentages of phosphorus and are lower in manganese. The total amount of manganese ore obtained in Georgia in 1902 was 3,500 long tons, while in 1889 it was 5,208 long tons, showing a decrease of 1,708 tons, or 32.8 per cent. The total production of this district from 1866 to 1902, inclusive—the output for some of the years being estimated—was 91,594 long tons, the maximum production being 9,024 long tons, in 1887.

Montana.—In previous years Montana has been an unimportant contributor of manganese ore, but in 1902 a large quantity of ore was reported as mined, but not shipped, from two deposits in this state. Although most of this will not be immediately available for use, the reported product is included in the statistical data. The deposits are located at a considerable distance from steel works, which are the largest consumers of this ore, and unless satisfactory rail rates are secured it is doubtful whether this state will become an important producer in the immediate future.

South Carolina.—As has been stated, the 8 tons of manganese ore which were secured near Greenwood, in this state, were shipped as a sample; no systematic mining has been reported.

Virginia.—Virginia was the most important producer of manganese ore in the United States in 1889, a total of 14,616 long tons being secured. Nearly all of this came from the Crimora mine, located in Augusta county, but after a few years this mine showed signs of exhaustion and mining operations were suspended. It has, however, been reopened in the hope of encountering new reserves of ore, and if these expectations are realized the state may again become an important contributor. The 1902 output was only 3,041 tons. The aggregate production from 1880 to 1902, inclusive, was 191,067 tons, the output of the year 1886, when 20,567 long tons were mined, being the maximum.

Table 10 is a detailed summary of the statistics of the manganese industry for the United States, by states, in 1902.

DESCRIPTIVE.

Manganese is not found in a metallic state in nature, but usually occurs as an oxide, carbonate, or silicate in combination with one or more of the other elements. The oxides are the most common of manganese minerals, but rhodonite and rhodochrosite—the silicate and the carbonate—are frequently met. The commercially important ores are the oxides—pyrolusite, psilomelane, braunite, manganite, hausmannite, and wad—brief descriptions of which follow:

Pyrolusite, a peroxide or binoxide of manganese (MnO_2), is of an iron-black color, giving a black streak on a test plate, with a hardness of 2 to 2.5 and a specific gravity of 4.8 to 5. If pure, it would yield 63.2 per cent of manganese and 36.8 per cent of oxygen. It is used in the manufacture of ferromanganese, in the production of chlorine, and in freeing glass from the brown or green color.

Psilomelane, one of the common ores of manganese, usually occurs associated with pyrolusite. It is also a binoxide or peroxide of manganese, but contains varying amounts of combined water, and often potassium, barium, and iron. It is generally massive (i. e., not crystallized), has a hardness of 5 to 6 (much harder than pyrolusite), and a specific gravity from 4 to 4.4. It is black, steel-blue, or greenish-black in color. Its uses are the same as those of pyrolusite, and by some it is considered a hydrated variety of this mineral. The manganese contents range, when the ore is pure, from 45 to 60 per cent.

Braunite is an anhydrous oxide of manganese (Mn_2O_3), usually containing silica. It is a black or brownish-black ore, generally crystalline, giving the same streak as pyrolusite on the test plate and having a submetallic luster. It has a hardness of 6 to 6.5 and a specific gravity of 4.8. When pure, which is rarely the case, it contains 69 per cent of metallic manganese.

Manganite, a hydrous sesquioxide of manganese ($Mn_2O_3H_2O$), is of a steel-black or iron-black color, with a hardness of 4 to 4.5 and a specific gravity of 4.3 to 4.4. When the water is removed from manganite it changes to pyrolusite, hausmannite, or braunite: in some cases the latter minerals are supposed to be altered manganite, this being especially true of pyrolusite.

Hausmannite, a double protobinoxide of manganese (Mn_3O_4), is of a brownish-black color and of a submetallic luster, with a hardness of from 5 to 5.5 and a specific gravity of 4.7. It is a rare mineral, which, if pure, would contain 72.1 per cent of manganese and 29.9 per cent of oxygen.

Wad, or bog manganese, is an impure peroxide of manganese, with peroxide of iron carrying from 10 to over 25 per cent of water, often several per cent of oxide of cobalt or copper, and sometimes nickel. Its hardness is from 1 to 6 and its specific gravity 3 to 4. The color varies from brown to black. It occurs in irregular masses in clay as solid beds several feet thick, but on account of its impurities is seldom used as a source of manganese, but is occasionally employed as the base for black or brown paint.

Both manganese and manganiferous ores are applied to the industrial arts, their uses being summarized as follows: As an alloy with iron in the production of ferromanganese and spiegeleisen manganese is employed in the conversion of iron into steel. It is also alloyed with copper, either with or without iron in manganese bronze, and with aluminum, zinc, copper, and silicon in silver bronze, and with aluminum, zinc, tin, lead, and magnesium.

Manganese ore is employed as a flux in smelting precious metals; it is utilized as an oxidizer in chemical works in the manufacture of chlorine and bromine; as a decolorizer of glass and also for coloring it; as a drier for varnishes and paints; for Leclanche batteries in the preparation of oxygen in a small way; in the manufacture of disinfecting permanganates, etc. It is also used as coloring material in printing, in pottery and brick, and for green and violet paints. Some varieties of manganese ore are also utilized in a limited way in medicine, in chemical laboratories, and in jewelry manufacture.

Most of the manganiferous ores are applied either to the production of spiegeleisen or as an integral part of the charge of an iron producing plant, or are fed to silver smelters as a flux.

TABLE 10.—DETAILED SUMMARY: 1902.

	United States.	California.	Georgia.	Virginia.	All other states.[1]
Number of mines	19	3	6	6	4
Number of operators	19	3	6	6	4
Character of organization					
Individual	8	2	2	1	3
Firm	5		1	3	1
Incorporated company	6	1	3	2	
Salaried officials, clerks, etc.:					
Total number	18		7	10	1
Total salaries	$9,395		$2,964	$4,241	$2,190
Superintendents, managers, foremen, surveyors, etc.—					
Number	11		5	5	1
Salaries	$7,354		$2,174	$2,990	$2,190
Foremen below ground—					
Number	5		1	4	
Salaries	$1,560		$450	$1,110	
Clerks—					
Number	2		1	1	
Salaries	$481		$340	$141	
Wage-earners:					
Aggregate average number	194	7	62	113	12
Aggregate wages	$74,924	$4,710	$21,161	$33,903	$15,150
Above ground—					
Total average number	125	2	50	73	
Total wages	$41,479	$1,500	$17,561	$22,418	
Engineers, firemen, and other mechanics—					
Average number	26		9	17	
Wages	$10,986		$5,255	$5,731	
Miners—					
Average number	33	2	25	6	
Wages	$12,245	$1,500	$8,760	$1,985	
Boys under 16 years—					
Average number	13		9	4	
Wages	$1,394		$954	$440	
All other wage-earners—					
Average number	53		7	46	
Wages	$16,854		$2,592	$14,262	
Below ground—					
Total average number	69	5	12	40	12
Total wages	$33,445	$3,210	$3,600	$11,485	$15,150
Miners—					
Average number	63	3	12	36	12
Wages	$31,310	$2,670	$3,600	$9,890	$15,150
Miners' helpers—					
Average number	3	2		1	
Wages	$884	$540		$344	
All other wage-earners—					
Average number	3			3	
Wages	$1,251			$1,251	
Average number of wage-earners at specified daily rates of pay:					
Engineers—					
$1.00 to $1.24	8		2	6	
$1.25 to $1.49	4			4	
$2.00 to $2.24	3		3		
Firemen—					
$1.00 to $1.24	4			4	
$2.00 to $2.24	3		3		
Machinists, blacksmiths, carpenters, and other mechanics—					
$1.00 to $1.24	2			2	
$2.00 to $2.24	2		1	1	
Average number of wage-earners at specified daily rates of pay—Cont'd.					
Miners—					
$1.00 to $1.24	77		37	40	
$1.25 to $1.49	1			1	
$1.50 to $1.74	1			1	
$2.50 to $2.74	5	5			
$3.50 to $3.74	12				12
Miners' helpers—					
$1.00 to $1.24	1			1	
$1.25 to $1.49	2	2			
Boys under 16 years—					
Less than $0.50	11		9	2	
$0.50 to $0.74	2			2	
All other wage-earners—					
$1.00 to $1.24	52		4	48	
$1.25 to $1.49	3		3		
$1.50 to $1.74	1			1	
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	165	15	53	85	12
February	144	15	53	64	12
March	172	15	53	92	12
April	178	15	53	98	12
May	167	6	53	96	12
June	185	6	53	114	12
July	180	6	53	109	12
August	184	6	53	113	12
September	167		53	102	12
October	196		53	131	12
November	206		53	141	12
December	228		53	163	12
Boys under 16 years—					
January	13		9	4	
February	13		9	4	
March	13		9	4	
April	13		9	4	
May	13		9	4	
June	13		9	4	
July	13		9	4	
August	13		9	4	
September	13		9	4	
October	13		9	4	
November	13		9	4	
December	13		9	4	
Miscellaneous expenses:					
Total	$3,845	$50	$2,915	$600	$280
Royalties and rent of mine and mining plant	$1,996		$1,575	$421	
Rent of offices, taxes, insurance, interest, and all other sundries	$1,849	$50	$1,340	$179	$280
Cost of supplies and materials	$17,228	$461	$6,866	$8,691	$1,210
Product:					
Quantity, long tons	16,477	846	3,500	3,041	9,090
Value	$177,911	$10,175	$20,830	$29,444	$117,462
Power, owned:					
Engines, steam—					
Number	11		4	7	
Horsepower	354		162	192	

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[1] Includes operators distributed as follows: Arkansas, 2; Montana, 1; South Carolina, 1.

LEAD AND ZINC ORE

LEAD AND ZINC ORE.

By Isaac A. Hourwich, Ph. D.

The present report deals only with mines producing nonargentiferous lead and zinc ores. The statistics relative to the production of lead and zinc incidental to mining for gold and silver are treated in the report on gold and silver.

The combination of the mining and smelting of lead in early times precluded separate statistics for each process. The census data relating specifically to lead mining were first presented in 1870. The earliest mention of zinc ore in census reports was in 1860, when 2 mines were reported with 52 employees and a value of product aggregating $72,600. Lead and zinc mining was reported at the census of 1870, and at the two subsequent censuses. Differences in the scope of the inquiry, and in the method of presenting the results, materially impair the value of the statistics of all these years for comparative purposes. At the Eleventh Census no statistics of wages, or of other expenditures, were shown for the zinc mines of southwestern Missouri; only the output, amounting to 186,262,308 pounds, valued at $2,024,057, was reported for that district. The statistics of the Eleventh Census are, therefore, omitted from the comparative summary given in the following table:

Table 1.—*Comparative summary: 1902, 1880, and 1870.*

	1902	1880	1870
Number of mines	559	206	[1]127
Number of operators	557	(2)	(2)
Salaried officials, clerks, etc.:			
Number	910	420	(2)
Salaries	$826,327	(3)	(2)
Wage-earners:			
Average number	7,881	7,063	1,711
Wages	$4,329,271	[3]$2,640,265	$600,628
Contract work	$108,607	(2)	(2)
Miscellaneous expenses	$2,092,001	(2)	(2)
Cost of supplies and materials	$2,511,675	$331,970	$78,687
Value of product	[4]$14,600,177	$3,837,161	$1,524,884

[1] Establishments.
[2] Not reported.
[3] Salaries included in wages.
[4] Includes $83,781, value of product of custom mills, and $1,913,810, for which the number of mines was not reported.

In order to make the data of the Eleventh Census comparable with those of the Twelfth, a summary of all mines, exclusive of the zinc mines of Missouri, is presented for the two years in the following table:

Table 2.—*Comparative summary, exclusive of zinc mines in Missouri: 1902 and 1889.*

	1902	1889
Number of mines	238	(1)
Salaries	$404,895	[2]$21,033
Wages	$2,042,821	$1,220,766
Contract work	$82,762	$31,511
Miscellaneous expenses	$495,298	$212,649
Cost of supplies and materials	$1,153,129	$407,938
Value of product	$5,713,601	$2,780,122

[1] Not reported.
[2] Salaries of foremen included in wages.

The total number of lead and zinc mines reported for the United States in 1902 is 559, and the total number of operators 557; the difference represents 2 incorporated companies in Virginia that operated iron mines in connection with zinc mines and are included in the report on iron mines; the statistics for the zinc mines, however, except those of capitalization, were segregated and are shown in this report.

Because of the prevalence of the leasing system in the operation of the lead and zinc mines, the terms "mine" and "operator" are indefinite in their meaning. The unit of these tables represents every operation for which a separate return was made. If the land was operated by its owner, the owner's report was included in the tables. Leasing companies whose business was confined to distributing land in small lots among operators and to drawing royalties, were not included in the general tables, unless some hired labor was employed by them in developing the mines. If the land was operated by a lessee with the help of hired labor, the lessee's report was tabulated. The numerous small sublessees, personally working in the mines, as a rule did not report; only 56 operators of that class made returns, and the statistics for these are included in the tables. The share contributed by this class of small operators to the lead and zinc production of Kansas and Missouri is shown in the following table:

TABLE 3.—DISTRIBUTION OF THE VALUE OF THE LEAD AND ZINC PRODUCTION OF KANSAS AND MISSOURI BY CLASS OF OPERATORS: 1902.[1]

CLASS OF OPERATOR.	KANSAS.				MISSOURI.			
	Total.	Per cent of total.	Lead ore.	Zinc ore.	Total.	Per cent of total.	Lead ore.	Zinc ore.
Total	$707,026	100.0	$163,084	$543,942	$12,513,021	100.0	$5,520,211	$6,992,810
Operators reporting	342,943	48.5	67,144	275,799	10,496,884	83.9	5,073,363	5,423,521
Sublessees not reporting	364,083	51.5	95,940	268,143	2,016,137	16.1	446,848	1,569,289

[1] Exclusive of the production of custom mills valued at $73,189.

Of the 557 operators reporting, only 90 owned the mines they operated, 461 were first lessees or sublessees, and 6 failed to report as to ownership. The Missouri lead and zinc mine inspector's list of mines enumerates 151 landowners; according to census returns for Missouri, 61 operators were owners of the lands they operated, which leaves 90 landowners whose mines were operated under the leasing system. The above number of lessees and sublessees does not include the numerous class of small sublessees who do the work themselves with pick and shovel. The number of such sublessees reported by landowners was 638, of whom 632 were reported from Missouri. This number, however, is very far from complete, an accurate count being precluded by the shifting character of this class of miners.

The unincorporated form of business organization was the prevailing form among operators. There were in all 398 unincorporated concerns and 161 corporations directly engaged in operating the mines. Judged by the volume of production, the corporations held a place of greater prominence in the lead-zinc mining industry than that held by unincorporated operators.

The share of each class of operators in the total production and the average output per mine are shown in the following table:

TABLE 4.—*Classification of lead and zinc mines, by character of ownership: 1902.*

CHARACTER OF OWNERSHIP.	Number of mines.	PRODUCT.		
		Value.	Per cent of total.	Average per mine.
Total	559	$14,600,177	100.0	[1] $22,695
Incorporated company	161	8,823,159	60.4	54,802
Firm	323	3,073,822	21.1	9,516
Individual	66	670,201	4.6	10,155
Other form	9	119,185	0.8	13,243
Form not reported	....	1,913,810	13.1	....

[1] Exclusive of those for which character of organization was not reported.

A summary for incorporated and unincorporated operators is presented in the following table:

TABLE 5.—*Summary for incorporated and unincorporated operators: 1902.*

	Total.	Incorporated.	Unincorporated.
Number of mines	[1] 559	[1] 161	398
Salaries	$826,327	$634,177	$192,150
Wages	$4,329,271	$2,928,788	$1,400,483
Contract work	$108,607	$49,903	$58,704
Miscellaneous expenses, exclusive of royalties	$566,633	$512,319	$54,314
Royalties	$1,525,368	$584,149	$941,219
Work on share of product	$234,461	$189,597	$44,864
Cost of supplies and materials	$2,511,657	$1,771,672	$739,985
Value of product, total	[2] $14,600,177	[3] $8,823,159	[4] $5,777,018
Lead—			
Quantity, short tons	[5] 132,330	[5] 105,409	26,921
Value	$5,850,721	$4,530,281	$1,320,440
Zinc—			
Quantity, short tons	[6] 491,332	[6] 326,576	164,756
Value	$8,665,675	$4,277,660	$4,388,015

[1] Includes 2 corporations whose capitalization is reported under iron ore.
[2] Includes $83,781, value of product from custom mills.
[3] Includes $15,218, value of product from custom mills.
[4] Includes $68,563, value of product from custom mills.
[5] Includes 10,023 tons, valued at $432,231, product of small operators not reporting.
[6] Includes 60,685 tons, valued at $1,533,548, product of small operators not reporting.

From the preceding table the average value per ton of lead ore is computed to be $44 for the product of all mines, $43 for incorporated and $49 for unincorporated operators. Average values of zinc ore drawn from the preceding statement would be misleading, inasmuch as the quantity and the value of zinc ore for incorporated companies and, consequently, for all mines in the United States, are affected by the returns of 3 large eastern mines—1 in New Jersey and 2 in Virginia—that produce low grade ore. In the following statement these mines are eliminated, and the average values, relating only to western ores, which are approximately of the same grade, disclose no substantial difference between incorporated and unincorporated forms of ownership:

Quantity and value of high grade zinc ore, mined by incorporated and unincorporated operators: 1902.

CHARACTER OF OWNERSHIP.	Short tons.	Value.	Average per ton.
Total	289,800	$8,022,522	$27.68
Incorporated	125,044	3,634,507	29.07
Unincorporated	164,756	4,388,015	26.63

Capital stock of incorporated companies.—The capitalization of the incorporated companies is shown in the following table:

TABLE 6.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.[1]	Colorado.	Illinois.	Kansas.	Missouri.	Wisconsin.	All other states.[2]
Number of incorporated companies	159	1	4	8	129	15	2
Capital stock and bonds issued	$51,326,891	$600,000	$330,000	$825,000	$34,958,891	$263,000	$14,350,000
Capital stock:							
Total authorized—							
Number of shares	8,612,792	1,000,000	250,300	531,500	6,495,822	231,670	103,500
Par value	$59,423,200	$1,000,000	$330,000	$725,000	$46,666,200	$352,000	$10,350,000
Total issued—							
Number of shares	6,198,299	600,000	250,300	516,500	4,585,329	142,670	103,500
Par value	$45,923,641	$600,000	$330,000	$710,000	$33,670,641	$263,000	$10,350,000
Dividends paid	$2,500,015			$3,015	$879,500	$17,500	$1,600,000
Common—							
Authorized—							
Number of shares	8,341,992	1,000,000	250,300	531,500	6,225,022	231,670	103,500
Par value	$56,380,200	$1,000,000	$330,000	$725,000	$43,623,200	$352,000	$10,350,000
Issued—							
Number of shares	5,973,526	600,000	250,300	516,500	4,360,556	142,670	103,500
Par value	$43,551,286	$600,000	$330,000	$710,000	$31,298,286	$263,000	$10,350,000
Dividends paid	$2,446,475			$3,015	$825,960	$17,500	$1,600,000
Preferred—							
Authorized—							
Number of shares	270,800				270,800		
Par value	$3,043,000				$3,043,000		
Issued—							
Number of shares	224,773				224,773		
Par value	$2,372,355				$2,372,355		
Dividends paid	$53,540				$53,540		
Bonds:							
Authorized—							
Number	15,265			340	4,925		10,000
Par value	$12,575,000			$115,000	$2,460,000		$10,000,000
Issued—							
Number	6,845			340	2,505		4,000
Par value	$5,403,250			$115,000	$1,288,250		$4,000,000
Interest paid	$226,200			$6,900	$59,300		$160,000
Assessments levied	$79,531				$64,531	$15,000	

[1] In addition there were 2 incorporated companies owning 2 mines in Virginia, and also owning and operating iron ore mines in West Virginia. The capitalization of these companies is reported under iron ore, since the capitalization for each industry can not be segregated.
[2] Includes 1 in New Jersey and 1 in New York.

The division of the capital stock into common and preferred is not in general use among the lead and zinc mining corporations. In the following statement the 159 operating companies are grouped in accordance with the class of stock reported by them:

Incorporated companies grouped by class of stock: 1902.

CLASS OF STOCK.	Number of incorporated companies.	AMOUNT ISSUED.		
		Total.	Common.	Preferred.
Total	159	$45,923,641	$43,551,286	$2,372,355
Both common and preferred	14	8,760,661	6,388,306	2,372,355
Common only	145	37,162,980	37,162,980	

The total bonded indebtedness reported was: Authorized, $12,575,000; issued, $5,403,250; the interest paid was $226,200. Among the companies for which a bonded indebtedness was reported were 2 companies whose capital stock and bonds represented manufacturing plants in addition to mining property. With these companies eliminated, there were in all 7 mining companies with an authorized bonded indebtedness aggregating $2,525,000, of which bonds to the value of $1,353,250 had been issued. One of these companies reported $200,000 as authorized but none issued; 4 reported an authorized indebtedness of $1,265,000, of which $1,220,000 was issued. The interest paid amounted to $63,200, the average rate being 5.2 per cent; 2 companies paid no interest on outstanding bonds during the year.

Few companies in the lead-zinc mining industry levied assessments. In 1902, 12 companies, 11 in Missouri and 1 in Wisconsin, reported total assessments since organization amounting to $79,531.

Of the 159 incorporated companies, only 45 declared dividends in 1902. Of this number, 3 companies operated smelting and other manufacturing establishments in connection with their mines, and their reported capitalization and dividends embraced their entire operations. The following table shows the capitalization and dividends of the 42 mining companies by which dividends were paid in 1902, exclusive of the 3 engaged in other business beside mining, and also the capitalization of the 114 companies by which no dividends were declared in 1902.

TABLE 7.—INCORPORATED COMPANIES, DIVIDEND AND NONDIVIDEND PAYING, BY KIND OF STOCK: 1902.[1]

CLASS.	AUTHORIZED.			ISSUED.			
	Number of shares or bonds.	Par value.		Number of shares or bonds.	Par value.		Dividends or interest paid.
		Total.	Average per share or bond.		Total.	Average per share or bond.	
Dividend paying companies.							
Total		$17,257,000			$11,458,550		$672,515
Common stock	2,447,350	14,757,000	$6.03	1,490,955	9,808,400	$6.58	618,975
Preferred stock	89,000	2,300,000	25.84	63,768	1,650,150	25.88	53,540
Bonds	400	200,000	500.00				
Companies paying no dividends in 1902.							
Total		28,191,200			21,568,341		63,200
Common stock	5,684,642	25,123,200	4.42	4,497,571	19,492,886	4.33	
Preferred stock	181,800	743,000	4.09	161,015	722,205	4.49	
Bonds	4,690	2,325,000	495.74	2,670	1,353,250	506.84	63,200

[1] Exclusive of 3 companies engaged in manufacturing as well as mining.

Of the 42 dividend paying companies whose dividends are shown in the preceding table, there were only 5 with both preferred and common stock; of these only 1 company declared dividends on both classes of stock, while 4 paid dividends on preferred stock alone. The average rate of dividends on preferred stock was 3.2 per cent. The 38 companies which declared dividends on common stock had an authorized capitalization of $11,957,000, divided into $10,957,000 common, and $1,000,000 preferred; of this the amount outstanding was $6,008,400 common and $425,550 preferred. The average rate of dividends paid by these companies on their common stock was 10.3 per cent.

The census returns furnish no data for determining the net profits earned in mining, since the excess of the value of the product over the expenses reported is not an indication of actual profit; yet some data bearing indirectly on the subject are found in the returns of the dividend paying companies. The payment of dividends by a company may ordinarily be taken as a proof of successful operation. Certainly it must not be assumed that the dividends paid during one year are derived from the profits of the same year, nor that the failure to declare a dividend during a certain year is an evidence of unprofitable mining. In the first case, the dividends may represent the accumulated earnings of former years, while in the second, the surplus may have been invested in the acquisition of new property, in the erection of new plants, etc. With these qualifications, the following comparative summary is presented:

TABLE 8.—*Summary for dividend paying and nondividend paying companies: 1902.*

	Incorporated companies.[1]	Dividend paying companies.	Nondividend paying companies.
Number of companies	156	42	114
Salaries	$594,016	$233,181	$360,835
Wages	$2,713,993	$951,865	$1,762,128
Contract work	$49,103	$21,377	$27,726
Work on share of product	$189,597	$189,597	
Royalties	$507,954	$273,119	$234,835
Miscellaneous expenses, exclusive of royalties	$495,809	$87,489	$408,320
Cost of supplies and materials	$1,612,098	$731,348	$880,750
Value of product	[2]$8,174,181	$3,502,890	[2]$4,671,291
Average value per company	$52,399	$83,402	$40,976
Lead.			
Quantity, short tons	105,085	33,949	71,136
Value	$4,525,081	$1,475,889	$3,049,192
Average value per ton	$43.06	$43.47	$42.86
Zinc:			
Quantity, short tons	124,919	69,453	55,466
Value	$3,633,882	$2,027,001	$1,606,881
Average value per ton	$29.09	$29.19	$28.97

[1] Exclusive of 3 companies engaged in manufacturing as well as mining.
[2] Includes product of custom mills.

It appears from the preceding table that the dividend paying companies enjoyed no advantage either in the grade of their ore or in the marketing of the same, since the average prices received by them did not perceptibly differ from those generally prevailing in 1902. But the two classes differed in the volume of production; the average for dividend paying companies was twice as large as that for the nondividend paying companies, the average being $83,402 and $40,976, respectively.

Employees and wages. The following table shows the average number of wage-earners employed during each month, by states and territories:

Table 9.—*Average number of wage-earners employed during each month, by states and territories: 1902.*

	United States.	Colorado.	Illinois.	Iowa.	Kansas.	Missouri.	Wisconsin.	All other states and territories.[1]
Men 16 years and over:								
January	7,325	......	97	12	175	6,135	445	[illegible]
February	7,266	......	94	[illegible]	[illegible]	6,153	415	421
March	7,465	......	96	16	187	6,277	427	462
April	7,608	......	111	[illegible]	209	6,415	393	467
May	7,965	20	115	16	207	6,726	364	517
June	7,996	20	[illegible]	[illegible]	197	6,750	386	508
July	8,008	20	82	7	227	6,766	390	516
August	8,181	......	98	9	238	6,890	407	539
September	8,067	......	114	16	258	6,659	437	553
October	8,125	......	92	12	270	6,729	463	559
November	8,034	......	82	13	273	6,710	481	525
December	8,172	......	131	17	258	6,768	482	556
Boys under 16 years:								
January	27	......	2	......	......	25	......	......
February	27	......	2	......	......	25	......	......
March	28	......	2	......	......	26	......	......
April	28	......	2	......	......	26	......	......
May	31	......	2	......	......	26	3	......
June	32	......	2	......	......	27	3	......
July	35	......	......	......	......	32	3	......
August	31	......	......	......	......	30	1	......
September	32	......	......	......	......	31	1	......
October	32	......	......	......	......	31	1	......
November	27	......	......	......	......	27	......	......
December	30	......	......	......	......	30	......	......

[1] Includes operators as follows: Arizona, 1; Kentucky, 1, New Jersey, 1, New Mexico, 1, New York, 1, Virginia (2 mines, operators reported under iron ore).

The number of salaried officials, clerks, etc., for the 559 mines reporting was 910, or an average of 1.6 to a mine. Of these 76 were salaried officials of corporations. Since the total number of corporations was 161, it appears that more than one-half of them had no salaried officials.

The average number of wage-earners was 7,881, or 14 to a mine. The aggregate wages paid amounted to $4,329,271. Miners working in the mines on shares are not included in the general tables.

In any analysis of these figures it must be borne in mind that the above number of wage-earners is an average computed on the basis of 300 working days, and is not identical with the actual number of persons who earned the amount of wages reported. The average per wage-earner accordingly represents the cost of one man's labor power to the employer, and this cost is not identical with the average annual earnings. For the purpose of estimating the earning capacity of wage-earners, average daily rates should be consulted.

In the following table the distribution of the wage-earners according to daily rates of pay is shown for the various occupations:

Table 10.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1]7,881	100.0	528	100.0	224	100.0	397	100.0	3,300	100.0	658	100.0	36	100.0	30	100.0	2,708	100.0
Less than 0.50	5	0.1													5	16.7		
0.50 to 0.74	14	0.2													12	40.0	2	0.1
0.75 to 0.99	7	0.1													5	16.7	2	0.1
1.00 to 1.24	165	2.1					1	0.3	47	1.4	4	0.6			5	16.7	108	4.0
1.25 to 1.49	1,371	17.4	2	0.4	53	23.7	11	2.8	300	9.1	302	45.9	11	30.6	1	3.3	691	25.5
1.50 to 1.74	2,053	26.0	44	8.3	104	46.4	54	13.6	909	27.5	183	27.8	7	19.4	2	6.6	750	27.7
1.75 to 1.99	683	8.7	73	13.8	7	3.1	51	12.8	308	9.3	21	3.2	3	8.3			220	8.1
2.00 to 2.24	2,301	29.2	176	33.3	41	18.3	159	40.0	1,217	36.9	124	18.8	13	36.1			571	21.1
2.25 to 2.49	788	10.0	85	16.1	8	3.6	49	12.3	414	12.6	24	3.7	1	2.8			207	7.7
2.50 to 2.74	309	3.9	117	22.2	10	4.5	42	10.6	93	2.8							47	1.7
2.75 to 2.99	26	0.3	5	0.9			7	1.7	2	0.1							12	0.4
3.00 to 3.24	143	1.8	24	4.6	1	0.4	17	4.3	8	0.3			1	2.8			92	3.4
3.25 to 3.49	10	0.1					3	0.8	1	(2)							6	0.2
3.50 to 3.74	4	0.1	1	0.2			2	0.5	1	(2)								
3.75 to 3.99	1	(2)					1	0.3										
4.00 to 4.24	1	(2)	1	0.2														

[1] Includes 2 wage-earners paid by the ton, for whom average daily wages are shown.

[2] Less than one-tenth of 1 per cent

In the above table 6,008 wage-earners, or 76.2 per cent of the total number, are included under the two heads "miners" and "all other wage-earners." It will be noticed also that there is comparatively little difference in the range of wages for the several classes of employees.

Of the total number of wage-earners, 7,196, or 91.3 per cent, received between $1.25 and $2.49 per day. Of those classed as miners the proportion included between those rates was even greater, constituting 95.4 per cent of all the miners. The number of miners who received $1.50 per day was evidently very large, as was also that of those who were paid $2 per day, for 27.5 per cent are included in the group $1.50 to $1.74 and 36.9 per cent in the group $2 to $2.24.

There were 658 men reported as miners' helpers. The daily rates of pay for 485 of them, 73.7 per cent of the total number, were between $1.25 and $1.74. Only 36 men were reported as timbermen and track layers; the rates of pay for 34 of these men ranged from $1.25 to $2.24. Most of the men employed as firemen received between $1.24 and $2.24 per day; 91.5 per cent of the total number was included between those rates. The rate at which the greatest number were employed was probably $1.50, since 46.4 per cent are included in the group $1.50 to $1.74. For engineers, machinists, and other mechanics wages were somewhat higher. Of the engineers, 93.7 per cent, and of the machinists and other mechanics, 89.3 per cent, were paid between $1.50 and $2.74 per day.

There were 30 boys under 16 years reported as employed in lead and zinc mines, 28 of them from Missouri. Of these boys, 12 were paid between 50 and 74 cents per day, 5 were paid less than 50 cents, while 5 received between 75 and 99 cents, and 8 received $1 or over.

The proportion of the employees included under the head of "all other wage-earners" is very large, but the range of wages differed very little from that for the balance of the wage-earners, 94.1 per cent of the total number having received between $1 and $2.49 per day.

Contract mining, i. e., working at a stated rate per ton, is exceptional in lead-zinc mining; according to the reports a total of $266 was paid for such work during the year, and this amount has been included in the general tables. In those mines, however, where the landowner or first lessee is also the buyer of all ore mined by the sublessees, the latter are virtually wage-earners paid by the ton. The total number of such sublessees reported was 638 and the total amount paid to them was $234,461; out of this amount they were required to furnish their own supplies.

The total number of men engaged in mining can not be ascertained with accuracy. The lead and zinc mine inspector of Missouri reported 11,358 men employed in all capacities at the lead and zinc mines; he explained, however, that "it must not be understood that this number is employed continuously, as quite a number of farmers mine in many counties when not engaged in farm work."[1] The census returns from the lead and zinc mines of Missouri show an average of 6,612 wage-earners and 777 salaried employees, in all 7,389 persons. The average number of the census is the number that would be required at continuous employment for 300 days in the year to produce the quantity of ore reported. The two numbers are incommensurate; the difference between them, 3,969 persons, would be much in excess of the average number of miners working on shares, as well as of the actual number of such miners who at one time or another during the year perform some work in the mines. Taking the value of ore produced as a basis, the average number of such miners could be estimated for Missouri at about 1,300 men.

The following table shows lead and zinc mines classified by the length of time in operation during the year, so far as reports were made in this particular:

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[1] Sixteenth Annual Report of the State Lead and Zinc Mine Inspector of Missouri, page 16.

TABLE 11.—LEAD AND ZINC MINES, CLASSIFIED BY NUMBER OF DAYS IN OPERATION, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Total.	DAYS IN OPERATION.												
		30 or less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 365.	Not reported
United States	539	25	44	40	55	42	31	50	50	58	109	26	4	5
Colorado	3			1										2
Illinois	14	1		1			1	1	1	1	5	3		
Iowa	14			2	1		1	3	4	2	1			
Kansas	57	3	4	5	7	7	4	7	4	2	11	1	2	
Missouri	354	19	36	26	36	27	23	29	31	45	69	11	2	
New Jersey	1											1		
New York	1		1											
Virginia	2					1					1			
Wisconsin	90	2	3	5	11	7	2	10	10	8	22	10		
All other states and territories[1]	3													3

[1] Includes Arizona, 1; Kentucky, 1; New Mexico, 1.

Mechanical power.—Steam was the prevailing kind of power in 1902. There were 1,060 steam engines, 45 electric motors, 32 gas or gasoline engines, 8 water wheels, and 39 other power generators in use during the year. Renting of power was practically unknown; the total number of horsepower supplied to other establishments by the operators reporting was 91, and the total supplied to the mines by other establishments was 199, while a total of 41,901 horsepower was owned. The progress in this respect within the last three decades is shown in the following table, by states and territories:

TABLE 12.—*Steam engines, by states and territories: 1902, 1880, and 1870.*

STATE OR TERRITORY.	1902		1880		1870	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
United States	1,060	38,616	167	6,739	21	953
Illinois	11	364	3	240	1	20
Iowa			1	25	1	40
Kansas	92	2,512	14	258		
Missouri	204	32,953	118	2,815	2	72
Wisconsin	25	617	3	37	1	85
All other states and territories[1]	25	2,170	28	3,364	13	736

[1] Includes the following states and territories. 1902: Arizona, Colorado, New Jersey, New York, and Virginia. 1880: New Jersey, Pennsylvania, and Tennessee. 1870: North Carolina and Pennsylvania.

Production.—In 1902 the dressing of the ore was done at the mine in nearly every case. Of the 559 concerns reporting, 525 were equipped with concentrating plants or hand jigs, 16 were custom mills, and 18 made no report as to equipment for treating the ore, presumably having no facilities for dressing their ore at the mine.

The total reported value of the product of the lead and zinc mines and mills in 1902 was $14,600,177. This amount was made up as shown in the following statement:

Value of the lead and zinc product: 1902.

Production of mines:		
Lead ore	$5,850,721	
Zinc ore	8,665,675	
Total		$14,516,396
Production of custom mills:		
Earned for custom work	34,309	
Ore sold	122,646	
Total	156,955	
Deduct cost of ore purchased	73,174	
Net value		83,781
Total, mines and mills		$14,600,177

While the production of custom mills adds to the value of the ore treated, it can not, theoretically at least, add anything to the quantity of the product; it would therefore be a duplication to add the product of the mills to that of the mines. In actual practice a portion of the product of the custom mills was recovered from "sludge," i. e., mill refuse purchased from the neighboring mines equipped with mills. The reports of the latter are assumed to include the value realized from the sale of sludge; it is, however, by no means certain that these values are included in all cases. The sludge is considered of little value; it is usually sold for a lump sum, without much regard to quantity. It is possible, therefore, that by deducting the value of purchased ore from the total value of the product the value of the lead and zinc product may have been underrated. Likewise, by omitting from the quantity of the product shown in Table 13, the output of custom mills, the total production may have been underrated. Still, as the gross value of all the ore sold by the mills amounted to only $122,646, or less than 1 per cent of the total production of the lead-zinc mines, the error may be treated as a negligible quantity.

The quantity, total value, and average value per ton of lead and zinc ore produced in 1902 are shown by states and territories in the following table:

TABLE 13.—QUANTITY, TOTAL VALUE, AND AVERAGE VALUE PER TON OF LEAD AND ZINC ORE, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	TOTAL.		LEAD ORE.			ZINC ORE.		
	Value.	Per cent of total.	Short tons.	Value.	Average value per ton.	Short tons.	Value.	Average value per ton.
United States[1]	$14,526,988	100.0	132,330	$5,861,313	$44.29	491,332	$8,665,675	$17.64
Illinois	90,619	0.6	792	30,936	39.06	2,778	59,683	21.48
Iowa	13,358	0.1	186	9,106	48.96	376	4,252	11.31
Kansas	707,036	4.9	3,468	163,094	47.03	21,642	543,942	25.13
Missouri	12,513,021	86.1	124,537	5,520,211	44.33	240,057	6,992,810	29.13
Wisconsin	473,652	3.3	2,623	122,184	46.58	19,376	351,468	18.14
All other states and territories[2]	729,312	5.0	724	15,792	21.81	207,103	713,520	3.45

[1] Does not include the production of custom mills in Kansas and Missouri.

[2] Includes the following states and territories: Arizona, Colorado, Kentucky, New Jersey, New Mexico, New York, and Virginia

The value of the lead and zinc ores shown in the preceding table is $14,526,988, or $73,189 less than the value of product shown in Table 1, and in the detailed summary. This difference is accounted for by the absence of the net value of the production of custom mills in Kansas and Missouri. According to the preceding table, six-sevenths of the lead and zinc production of the United States was furnished by the state of Missouri.

The progress made by the lead-zinc mining industry since the Eleventh Census appears from the following comparative summaries:

TABLE 14.—*Comparative summary, quantity and value of lead ore, by states and territories: 1902 and 1889.*

STATE OR TERRITORY.	SHORT TONS.			VALUE.		
	1902	1889	Per cent of increase.	1902	1889	Per cent of increase.
United States[1]	132,330	50,238	163.4	$5,861,313	$1,754,380	234.1
Missouri	124,537	44,482	180.0	5,520,211	1,571,161	251.4
Kansas	3,468	3,617	[2]4.1	163,084	103,236	58.0
Wisconsin	2,623	1,678	56.3	122,184	64,063	90.7
Illinois	792	173	357.8	30,936	4,800	544.5
Iowa	186			9,106		
All other states and territories	[3]724	[4]288	151.4	[3]15,792	[4]11,120	42.0

[1] Does not include the production of custom mills in Kansas and Missouri in 1902.

[2] Decrease.

[3] Includes Arizona, Colorado, Kentucky, New Jersey, New Mexico, New York, and Virginia.

[4] Southern states.

TABLE 15.—*Comparative summary, quantity and value of zinc ore, by states and territories: 1902 and 1889.*

STATE OR TERRITORY.	SHORT TONS.			VALUE.		
	1902	1889	Per cent of increase.	1902	1889	Per cent of increase.
United States[1]	491,332	234,503	109.6	$8,665,675	$3,049,799	184.1
Missouri	240,057	93,131	157.8	6,992,810	2,024,057	245.5
Kansas	21,642	39,575	[2]45.3	548,942	299,192	81.8
Wisconsin	19,376	24,832	[2]22.0	351,468	400,568	[2]12.3
Illinois	2,778			54,683		
Iowa	375	450	[2]16.7	4,252	3,600	18.1
Eastern states	[3]201,532	[4]63,339	218.2	[3]643,153	[4]175,052	267.4
All other states and territories	[5]5,572	[6]13,176	[2]57.7	[5]70,367	[6]147,330	[2]52.2

[1] Does not include the production of custom mills in Kansas and Missouri in 1902.

[2] Decrease.

[3] Includes New Jersey and Virginia.

[4] Includes New Jersey and Pennsylvania. Number not reported.

[5] Includes Colorado, Kentucky, and New Mexico.

[6] Includes Arkansas, New Mexico, and the Southern states.

In the following statement the census returns for Missouri are compared with the report of the lead and zinc mine inspector of that state:

Quantity and value of lead and zinc ore, Census and Missouri mine inspector's returns: 1902.

SOURCE OF INFORMATION.	Total value.	LEAD ORE.			ZINC ORE.		
		Short tons.	Value.	Average value per ton.	Short tons.	Value.	Average value per ton.
Census returns[1]	$12,513,021	124,537	$5,520,211	$44.33	240,057	$6,992,810	$29.13
State mine inspector's returns	12,370,985	126,831	5,318,157	41.93	234,903	7,052,828	30.02
Difference:							
More (+) or less (–)	–142,036	+2,294	–202,054	–2.40	5,154	+60,018	+0.89
Per cent	1.1	+1.8	–3.7	–5.4	2.1	+0.8	+3.0

[1] Exclusive of production of custom mills.

As evidenced by the preceding statement, the census returns on production are in substantial agreement with those of the state mine inspector. Small discrepancies of from 1 to 3 per cent are quite unavoidable in view of the nature of the information. In many cases the value reported by the operator was not the actual amount entered on his books, but an estimate based upon an assumed average value of the ore, which was the best information obtainable. Small operators only too often keep very imperfect books, if any, whereas the largest producers, who do not sell their ores but smelt them at their own plants and market the bullion, must put an assumed valuation upon the ore in order to answer the inquiries of the Bureau of the Census or of the state bureau of mines. Therefore, if the reports of such operators were made on different dates, the estimates for the same mining company might differ, and in more than one case this state of affairs was disclosed by a comparison of the confidential census returns with the figures published by the state mine inspector. That the discrepancy is on the whole within such narrow limits may be accepted as proof of the substantial accuracy of the returns.

The mining district comprising Kansas and a portion of Missouri is called the Joplin-Galena district. The average base prices of zinc and lead ores in this district, computed from monthly averages for 1902, were reported by the United States Geological Survey as follows: Lead per 1,000 pounds, $23.05; zinc per short ton, $30.33. For 1902 the range of fluctuations of monthly base prices in the same district was as follows:

	Lead ore per 1,000 pounds.	Zinc ore per short ton.
Highest price	$25.00	$34.37
Lowest price	21.00	26.76
Variation	4.00	7.61

These averages are not strictly comparable with the average values by states and territories given in Table 13. The variations, however, are inconsiderable, viz:

Average value above (+) or below (–) base price.

	Lead ore per 1,000 pounds.	Zinc ore per short ton.
Kansas	$0.46	–$5.20
Missouri	– 0.89	+ 1.20

It appears from these comparisons that the variations between the values reported to the Bureau of the Census and the average base prices for the year 1902 were within the ordinary range of market fluctuations. The quantity reported represents dressed ore of various grades, except in a few cases where the quantity of rough ore was reported and could not be reduced to terms of dressed ore.

Table 16 is a summary of the statistics for all lead and zinc mines in Missouri at the censuses of 1902, 1880, and 1870.

Table 16.—*Comparative summary, lead and zinc mines, Missouri: 1902, 1880, and 1870.*

	1902	1880	1870
Number of mines	374	71	42
Number of operators	374	71	42
Salaried officials, clerks, etc.:			
Number	777	342	(1)
Salaries	$727,021	(2)	(1)
Wage-earners:			
Average number	6,612	4,190	539
Wages	$3,691,923	[2]$2,034,254	$124,179
Contract work	$106,877	(1)	(1)
Miscellaneous expenses	$1,768,458	(1)	(1)
Cost of supplies and materials	$2,189,461	$194,532	$5,654
Value of product	$12,555,580	$2,077,944	$201,88[illegible]

[1] Not reported. [2] Salaries included in wages.

As has been stated above, at the Eleventh Census the statistics of zinc mines of southern Missouri were confined to the quantity and value of the output. Mine expenses were reported only for lead mines. In the following table the data concerning these mines are collated with the expenses and production of the mines for which the product reported for 1902 was likewise only lead ore:

Table 17.—*Comparative summary of mines producing lead ore only, Missouri: 1902 and 1889.*

	1902	1889
Number of mines	59	[illegible]
Salaries	$338,290	(1)
Wages	$1,448,902	$401,431
Contract work	$30,031	$8,525
Miscellaneous expenses	$465,212	$142,158
Cost of supplies and materials	$842,945	$244,784
Product:		
Short tons	95,925	44,482
Value	$4,126,278	$1,571,161

[1] Not reported.

The following table, reproduced from the report of the state lead and zinc mine inspector of Missouri for 1902, shows the growth of the zinc production in that state, by years, from the beginning of zinc mining, in 1873, to the year 1902. The output of 1902, as reported by the state mine inspector, exceeds by eight-tenths of 1 per cent that reported to the Bureau of the Census. The reasons for this insignificant variance are discussed on a previous page.

Table 18.—*Quantity and value of zinc ore, Missouri: 1873 to 1902.*

[Sixteenth Annual Report of the Lead and Zinc Mine Inspector of Missouri, for the year ending December 31, 1902.]

YEAR.	Number of tons.	Amount received for output.	YEAR.	Number of tons.	Amount received for output.
1873	960	$8,640.00	1890	100,248	$2,256,593.00
1874	5,100	51,000.00	1891	123,752	2,673,063.36
1875	3,600	36,000.00	1892	131,488	2,902,475.08
1876	11,300	148,000.00	1893	108,591	2,245,028.80
1877	10,000	140,000.00	1894	89,150	1,337,910.36
1878	12,000	198,000.00	1895	101,294	1,707,665.40
1879	20,000	340,000.00	1896	92,754	1,831,850.45
1880	27,500	440,000.00	1897	93,148	1,706,947.53
1881	35,500	579,150.00	1898	139,668	2,927,321.00
1882	34,900	589,100.00	1899	181,430	5,974,624.00
1883	35,700	624,750.00	1900	196,293	5,711,631.00
1884	43,200	777,600.00	1900[1]	105,150	2,835,995.00
1885	42,200	738,500.00	1901	224,074	5,308,671.00
1886	48,400	895,400.00	1902	234,903	7,052,819.00
1887	57,300	1,068,700.00			
1888	61,350	1,292,550.00	Total	2,448,510	56,145,615.06
1889	82,357	1,765,731.08			

[1] For ten years prior to 1901 the above figures covered a fiscal year ending June 30. The six months accounted for above are the last six months of 1900, making full years for the period.

LEAD CONTENTS OF LEAD AND ZINC ORES.

The lead contents of the ore can be estimated by comparison with the returns from lead smelters. The returns from 5 leading mining and smelting companies of Missouri show a total of 103,428 tons of their own and purchased ore treated, from which 70,491 tons of lead were recovered, or an average of 68.2 per cent. The quantity of nonargentiferous lead ore treated by those companies is equal to 78 per cent of the total quantity mined during the year. A glance at the price column of Table 13 shows that the ore was brought by concentration to about the same grade throughout the nonargentiferous lead region. The only exception is found in the group of "all other states," where the quantity reported apparently represented crude ore. The quantity, however, being only somewhat over two-tenths of 1 per cent, the effect of this variation upon the average for the United States could not exceed a few cents per ton. The average percentage of recovery reported by the above-mentioned 5 smelting companies—viz, 68 per cent—may therefore be taken as representative of the results generally obtained in the United States.[1] The metal yield of all nonargentiferous ores may be estimated on this basis, in round figures, at 90,000 tons. According to reports from the same companies, lead bullion of the value of $2,534,683 was produced from concentrates valued at $2,045,978—i. e., 24 per cent was added to the value of concentrates by smelting. The total reported value of the lead concentrates produced in the United States was $5,850,721. By an addition of 24 per cent of this amount $7,255,000 is obtained as the estimated value of the 90,000 tons of metallic lead recoverable from nonargentiferous ores. The average value is 4.03 cents per pound of refined lead, which is within the range of the prices of lead at New York city in 1902 as reported by the United States Geological Survey—viz, highest, 4.10 cents; lowest, 4 cents. The reports made by smelters to the United States Geological Survey show 79,445 tons of pig lead produced from nonargentiferous ores of Missouri, Kansas, Wisconsin, Illinois, Iowa, Virginia, and Kentucky. The difference is accounted for by the fact that "a considerable quantity of the ore is converted into a pigment."[1]

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[1] The relation of the product to lead ores consumed in 1880 was represented by the following percentages: Illinois, 68.6; Iowa, 70.2; Wisconsin, 66.6; Kansas, 69.3; and Missouri, 72.4.

ZINC CONTENTS OF LEAD AND ZINC ORES.

The zinc ores of Missouri and Kansas are usually sold upon an assay basis of 60 per cent of metallic zinc in the concentrates, with a deduction of $1 for every unit or percentage below that standard, and a similar allowance for higher grades of concentrates. Sixty per cent is thought to be, approximately, the average for the entire district.

The price of ore shipped from mines in Wisconsin is determined by the price of ore in Missouri. The average value per ton of zinc ore in Missouri was $29.13, and in Wisconsin $18.14; the difference, $10.99, may be taken as reflecting the difference in the grade of the concentrates, and would show an average assay of 49 per cent for Wisconsin ore (dressed). The three states named furnished 278,727 tons out of a total of 283,680 tons for the Western states, or 98.3 per cent of the total output of western mines. The eastern and southern ores are of a much lower grade. The average zinc contents of New Jersey concentrates was about 25 per cent; the chemical composition of the ore, according to Mr. Ingalls, is 23.58 per cent zinc. The concentrates of Virginia assay 38.08 zinc.[2] From these data the zinc contents of the ores mined are estimated for the principal producing states as follows:

TABLE 19.—*Zinc contents of ores mined in the principal producing states: 1902.*

STATE.	Short tons of concentrates.	Average assay (per cent).	Zinc contents (short tons).
Total	482,657	....	217,723
Missouri	240,057	60	144,034
Kansas	21,642	60	12,985
Wisconsin	19,376	49	9,491
New Jersey[1]	201,582	25	51,213
Virginia[1]		38	

[1] The computation is made separately for New Jersey and Virginia, but the returns can not be shown separately without disclosing individual operations.

This leaves 8,725 tons of ore, or about 2 per cent, the zinc contents of which are a matter of conjecture.

GENERAL SUMMARY OF LEAD AND ZINC MINES, BY STATES AND CHARACTER OF MINE.

A table for all lead and zinc mines is presented by states. Small mines from which no individual reports were received are not included in this statement. The royalties shown in the detailed summary at the close of this report include those paid by these sublessees; therefore royalties are omitted also. The rate of royalty is fixed by custom and does not, as a rule, vary in individual cases. Custom mills which merely rework ore mined elsewhere or mill refuse ("sludge") are not included in the following table which is intended to present the facts relating to mines only:

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 209.

[2] Production and Properties of Zinc, by Walter Renton Ingalls, pages 193 and 201.

TABLE 20.—SUMMARY OF LEAD AND ZINC MINES, BY STATES: 1902.

STATE.	Number of mines.	Salaries.	Wages.	Contract work.	Work on share of product.	Miscellaneous expenses, exclusive of royalties.	Cost of supplies and materials.	Value of product.
United States[1]	541	$818,461	$4,244,156	$108,607	$244,661	$543,172	$2,048,903	$12,550,617
Illinois	14	9,120	51,565	....	....	1,226	20,464	90,619
Iowa	14	290	5,766	....	....	756	919	13,358
Kansas	54	20,783	129,584	922	....	10,235	72,453	342,948
Missouri	362	721,905	3,650,237	105,877	228,664	512,996	1,718,719	10,963,291
Wisconsin	90	26,202	192,209	1,008	....	1,638	56,774	473,652
All other states[2]	7	40,161	214,795	800	15,997	16,510	179,574	666,751

[1] Custom mills and small mines not included.

[2] Includes operators distributed as follows: Colorado, 3; New Jersey, 1; New York, 1; Virginia, 2.

In analyzing the figures of the preceding table, the prevalence of mining on a small scale in Iowa and Wisconsin should be taken into consideration. In a mine worked on a small scale the operator gives his personal attention to many details of business which on a larger scale of operation require the services of salaried employees; furthermore, the absence of steampower in the great majority of these mines reduced the expense for supplies.

Where the same mine produces both lead and zinc ore, it is impossible to segregate the expenses incident to each of these products. There were a number of mines, however, which reported but one product, either lead or zinc ore.

The following is a comparative summary of all mines, classified according to the character of their product, the division showing those producing lead ore only, those producing zinc ore only, and those producing both lead and zinc ore:

TABLE 21.—SUMMARY OF MINES, BY CHARACTER OF PRODUCT: 1902.

CHARACTER OF PRODUCT.	Number of mines.	Salaries.	Wages.	Contract work.	Work on share of product.	Miscellaneous expenses, exclusive of royalties.	Cost of supplies and materials.	Value of product.	LEAD.			ZINC.		
									Short tons.	Value.	Value per ton.	Short tons.	Value.	Value per ton.
United States¹	541	$818,451	$4,241,256	$108,607	$244,661	$543,172	$2,058,933	$12,550,617	122,307	$5,418,490	$44.30	430,647	$7,132,127	$16.56
Lead ore	108	314,875	1,493,068	30,031	27,139	384,715	855,514	4,209,174	95,790	4,209,174	43.94	....	....	....
Zinc ore	144	171,792	841,233	12,792	....	67,014	590,756	2,467,623	....	....	....	263,985	2,467,623	9.35
Lead and zinc ore	289	331,784	1,906,955	65,784	217,522	91,443	612,663	5,873,820	26,517	1,209,316	45.61	166,662	4,664,504	27.99

[1] Custom mills and small mines not included.

The average value realized per ton of lead ore shows no marked difference for either class of lead mines. The average values per ton of zinc ore, shown in the preceding table, are misleading because they include the low grade zinc ores of New Jersey and Virginia. When those ores are eliminated, the total output of distinctively zinc mines is reduced to 62,453 tons, valued at $1,824,470, which corresponds to an average value of $29 per ton. Thus there is no perceptible difference in the average value of zinc ore of the same class.

The following is a comparative summary of zinc mines by districts, viz, Kansas and Missouri, which is the main zinc producing region; the upper Mississippi valley, extending over Wisconsin, Illinois, and Iowa; and the Eastern states, embracing New Jersey and Virginia:

TABLE 22.—SUMMARY FOR MINES PRODUCING ZINC ORE EXCLUSIVELY, BY DISTRICTS: 1902.

DISTRICT.	Number of mines.	Salaries.	Wages.	Contract work.	Miscellaneous expenses, exclusive of royalties.	Cost of supplies and materials.	PRODUCT.		
							Short tons.	Value.	Average per ton.
United States	144	$171,792	$841,233	$12,792	$67,014	$590,756	263,985	$2,467,623	....
Kansas and Missouri	113	125,544	572,652	11,965	50,287	414,216	56,236	1,702,829	$30.28
Upper Mississippi valley¹	28	8,312	62,821	827	747	19,966	6,217	121,641	19.57
Eastern states²	3	37,936	205,760	....	15,980	156,574	201,532	643,153	3.19

[1] Includes mines as follows: Illinois, 3; Iowa, 2; Wisconsin, 23.

[2] Includes mines as follows: New Jersey, 1; Virginia, 2.

The following table is a summary for lead mines yielding no zinc by product, by districts:

TABLE 23.—SUMMARY FOR MINES PRODUCING LEAD ORE EXCLUSIVELY, BY DISTRICTS: 1902.

DISTRICT.	Number of mines.	Salaries.	Wages.	Contract work and work on share of product.	Miscellaneous expenses, exclusive of royalties.	Cost of supplies and materials.	PRODUCT.		
							Short tons.	Value.	Average per ton.
United States	108	$314,875	$1,493,068	$57,170	$384,715	$855,514	95,790	$4,209,174	$43.94
Missouri	59	308,290	1,448,902	57,170	383,180	842,845	93,926	4,126,278	43.93
Upper Mississippi valley¹	49	6,585	44,166	....	1,535	12,669	1,864	82,896	44.47

[1] Includes mines distributed as follows: Illinois, 10; Iowa, 12; Wisconsin, 27.

A detailed summary of the lead and zinc ore industry for 1902 is given in Table 34.

AURIFEROUS AND ARGENTIFEROUS LEAD AND ZINC ORES.

The statistics of mines producing auriferous and argentiferous lead and zinc ores are given in the report on gold and silver. Still, as these ores furnish a not inconsiderable share of the materials from which lead and zinc are produced in this country, a proper comparison of the production of the mines with the consumption of the lead and zinc ores must embrace all classes of these ores. The production of lead and zinc from all sources, as returned by the census of mines and quarries for the year 1902, is collated in the following statement:

Value of lead and zinc in all ores, by sources of production: 1902.

	Lead.	Zinc.
Total	$18,181,013	$9,006,361
In nonargentiferous lead and zinc ores	5,850,721	8,596,675
In gold and silver ore	12,311,279	409,686
In copper ore	19,013	....

Mr. Harry A. Lee, commissioner of mines of Colorado, in his report for 1901–2, wrote as follows of zinc mining in that state:

> Zinc is practically a new product that occurs intimately associated with iron and lead sulphides in bodies of great magnitude. Until within the past few years these ore bodies were worthless on account of the zinc sulphides present, and were, therefore, as far as possible, left intact in the mines. The extraction of the more valuable ores has, nevertheless, developed large bodies of zinciferous ores that are now a valuable asset.[1]

Zinc associated with gold, silver, and lead was reported from Colorado, where, according to census returns, 51,996,073 pounds of zinc were contained in 245,555 tons of gold and silver bearing lead ore, showing an average assay of 10.6 per cent of zinc in the ore. In addition to this, the reports from nonargentiferous lead and zinc mines included in the preceding statements show a product of 1,536 tons of zinc concentrates. The commissioner of mines estimated the production for 1902 at 52,582,510 pounds of zinc. This leaves 586,437 pounds for the contents of 1,536 tons of nonargentiferous lead and zinc ore included in previous statements, which would correspond to 19.5 per cent of zinc in the dressed ore. The estimate is apparently too low.

The value reported to the Bureau of the Census is $335,436 for the zinc contents of argentiferous ore and $18,398 for the lead and zinc ores; in all, $353,834. The value reported by the commissioner of mines was computed at the average price for spelter, 4.84 cents per pound, which amounts to $2,544,993. The price realized by the mine operator was about 13.9 per cent of the value of metallic zinc contained in the ore.

The mineralogical character of the zinc bearing ores of Colorado is shown in the following statement:

Assay contents of the zinc ores of Colorado: 1902.

CLASS OF ORE.	Number of mines reporting.	Gold value.	Silver value.	LEAD.		ZINC.	
				Pounds.	Value.	Pounds.	Value.
Total	12	$139,619	$633,114	11,316,284	$260,412	51,996,072	$335,436
Associated with gold and silver	2	540	1,987			574,753	5,260
Associated with gold, silver, and lead	7	139,079	616,875	9,290,784	230,206	47,395,139	298,796
Associated with silver and lead	3		14,252	2,025,500	30,206	4,026,180	31,380

A classification of these zinc bearing ores by the commercial value of the principal metal is presented in the following statement:

Classification of zinc bearing ores of Colorado by the commercial value of the principal metals: 1902.

COMPOSITION OF THE ORE.		Value of zinc contents.
Metals of chief value.	Other metals.	
Total		$335,436
Gold and silver	Lead	150,731
Lead	Gold and silver	45,562
Zinc	Lead, gold, and silver	139,143

As appears from the preceding statement, most of the Colorado zinc was a by-product of auriferous and argentiferous lead ore. Lead smelters very reluctantly handle this class of ore; they make no allowance for the zinc, and even charge a penalty in case the assay shows zinc in excess of a certain percentage. According to Census reports, concentration and magnetic separation of zinc ore have been introduced at some mines. Shipments of zinc ore were made to Kansas zinc smelters and to New York for export. Under the stimulus of the growing supply of zinc ore, zinc works have been recently erected in Colorado.

Reports from Utah show 19,582,443 pounds of zinc among the contents of argentiferous lead ore. With the exception of a small shipment assaying 105,000 pounds of zinc, no returns were brought by the zinc, although the rough ore assayed 4.2 per cent zinc. The ore was bought by lead smelters for its gold, silver, and lead contents. In Utah as well as in Colorado there were other mines which produced zinciferous ores; but since the operators received no returns for their zinc, they kept no records of the same, and failed to report it to the Bureau of the Census.

Consumption of zinc ore.—The zinc contents of lead and zinc ore were estimated above at 217,726 tons, exclusive of the contents of 8,725 tons, which could not be estimated with any degree of accuracy. The zinc contents of auriferous and argentiferous ores were given in Census reports from Colorado as 25,998 tons. The reports from Utah showed one shipment of ore assaying 52 tons of zinc, for which payment was received. This makes a total of 243,776 tons of zinc and 8,725 tons of zinc ore. No account is taken of zinciferous ore shipped to lead smelters, there being no positive information to show how the zinc contents of such ores were utilized, or even that they were utilized at all.

The production of spelter for 1902 was reported by the United States Geological Survey as 156,927 tons. Allowing 15 per cent for the loss in smelting, the zinc contents of the ores from which this output was extracted, may be estimated at 184,600 tons. To this must be added the output of zinc oxide, which is manufactured in the United States directly from the ore. The production of zinc oxide for 1902 is estimated[1] at 52,730 tons. The zinc contents of this product, figured at the rate of 80.3 per cent of zinc in the oxide, were equal to 42,342 tons. The total output of zinc in all forms for 1902 may be estimated therefore at 226,942 tons, or in round numbers at 227,000 tons.

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[1] Report of the State Bureau of Mines of Colorado for the years 1901–2, page 105.

[1] The Mineral Industry, Vol. XI, page 600.

The exports of zinc ore for the calendar year 1902 were 49,762 long tons,[1] or 55,733 short tons. Of this quantity, 20,883 long tons were exported through New York; the rest, with the exception of a small quantity, was exported through Galveston. The New York exports represented New Jersey ores which contained, at an assay rate of about 25 per cent, 5,221 long tons or 5,847 short tons of zinc. The estimated production and consumption would thus compare as follows:

Production and consumption of zinc: 1902.

	Zinc (short tons).	Ore (short tons).
Total production	243,776	8,725
Domestic consumption in the manufacture of spelter and oxides	227,000	....
Exports:		
New Jersey ores	5,847	....
Other ores [1]	....	32,344
Total consumption	232,847	32,344
Excess (+) or deficiency (−) of production over consumption	+10,929	−23,619

[1] 28,879 long tons.

The deficiency of 23,619 tons of ore in the preceding calculation is covered by the excess of 10,929 tons of zinc, which corresponds to an average tenor of 46 per cent zinc in western ores. No account is taken here of the increase or decrease of the stock of ore. It must be understood that these are only rough estimates, allowing a wide range for error.

Tendency toward centralization.—The lead-zinc mining industry has not escaped the general trend of modern business toward centralization. In this respect a marked difference in degree exists between those mines which may be classed as zinc mines, lead being mined only as a by-product, and those which may properly be classed as lead mines, zinc occurring, if at all, as a by-product.

The following table shows the distribution of lead mines by value of production in 1902:

TABLE 24.—*Classification of lead mines by value of product: 1902.*[1]

PRODUCT PER MINE.	Number of mines.	VALUE OF PRODUCT.			
		Total.	Per cent of total.	Lead.	Zinc.
Total [2]	176	$4,963,625	100.0	$4,743,264	$220,361
Less than $500	45	9,335	0.2	8,777	558
$500 to $999	23	17,784	0.4	15,848	1,936
$1,000 to $9,999	66	210,540	4.2	181,378	29,162
$10,000 to $49,999	29	595,892	12.0	484,236	111,656
$50,000 to $99,999	5	381,737	7.7	304,688	77,049
$100,000 to $499,999	5	1,250,719	25.2	1,250,719	....
$500,000 and over	3	2,497,618	50.3	2,497,618	....

[1] A classification by states is impossible without disclosing the identity of some individual establishments.
[2] Custom mills and small mines not included.

The following table shows the zinc mines classified by value of production:

TABLE 25.—*Classification of zinc mines by value of product: 1902.*[1]

PRODUCT PER MINE.	Number of mines.	VALUE OF PRODUCT.			
		Total.	Per cent of total.	Zinc.	Lead.
Total [2]	365	$7,586,992	100.0	$6,912,030	$674,962
Less than $500	26	6,305	0.1	6,020	285
$500 to $999	28	19,586	0.2	17,908	1,678
$1,000 to $9,999	150	629,497	8.3	552,228	77,269
$10,000 to $49,999	118	3,050,173	40.2	2,751,249	298,924
$50,000 to $99,999	36	2,372,151	31.3	2,177,674	194,477
$100,000 and over [3]	7	1,509,280	19.9	1,406,951	102,329

[1] A classification by states is impossible without disclosing the identity of some individual establishments.
[2] Custom mills and small mines not included.
[3] Includes 1 establishment reporting a product of over $250,000 but less than $500,000, and 1 reporting a product of over $500,000.

Missouri.—The state lead and zinc mine inspector of Missouri, in his report for 1902, noted the decrease within recent years of the number of individual operators, who were giving place to large and strong companies.[1] As the mines of Missouri furnish the bulk of the zinc and soft lead production of the United States, the tendencies observed in Missouri may be said to be representative of the industry in general.

In soft lead mining the progress of centralization is far in advance of that manifested by the zinc mining industry. The degree of centralization reached in each branch appears from Tables 26 and 27, which show the distribution of all operators by value of production. This classification does not include the great number of sublessees employing no hired labor.

TABLE 26.—*Classification of lead mines, Missouri, by value of product: 1902.*[1]

PRODUCT PER MINE.	Number of mines.	VALUE OF PRODUCT.			
		Total.	Percentage of total.	Lead.	Zinc.
Total	108	$4,788,799	100.0	$4,596,606	$192,193
Less than $500	20	3,643	0.1	3,190	453
$500 to $999	15	11,248	0.2	9,888	1,360
$1,000 to $9,999	37	127,020	2.6	104,039	22,981
$10,000 to $49,999	23	516,814	10.8	426,464	90,350
$50,000 to $99,999	5	381,737	8.0	304,688	77,049
$100,000 to $499,999	5	1,250,719	26.1	1,250,719	....
$500,000 and over	3	2,497,618	52.2	2,497,618	....

[1] Exclusive of the production of sublessees who employ no hired labor.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 225.

[1] Sixteenth Annual Report of the State Lead and Zinc Mine Inspector of Missouri, pages 10 and 11.

TABLE 27.—*Classification of zinc mines, Missouri, by value of product: 1902.*[1]

PRODUCT PER MINE.	Number of mines.	VALUE OF PRODUCT.			
		Total.	Per cent of total.	Zinc.	Lead.
Total	254	$6,174,495	100.0	$5,587,181	$587,314
Less than $500	19	4,486	0.1	4,222	264
$500 to $999	15	11,197	0.2	10,523	674
$1 000 to $9,999	82	366,072	5.9	326,533	39,539
$10,000 to $49,999	98	2,600,174	42.1	2,343,122	257,052
$50,000 to $99,999	34	2,266,991	36.7	2,079,535	187,456
$100,000 and over[2]	6	925,575	15.0	823,246	102,329

[1] Exclusive of the production of sublessees who employ no hired labor.
[2] Includes 1 establishment reporting a product of over $250,000.

It is apparent from the preceding tables that the bulk of the zinc mine output of Missouri is the result of production on a middle scale, or from $10,000 to $100,000; very large producers, as well as the very small, falling far behind, while over three-quarters of the output of soft lead is furnished by 8 mines, with a production of more than $100,000 each. Three operators, each with an output exceeding $500,000, produced over one-half of the lead output of the state.

Tables 28 and 29, showing the correlation between the value of production and ownership of mineral lands, have been compiled in this office from the individual reports of mining companies published in the annual report of the lead and zinc mine inspector of the state of Missouri for the year 1902.

TABLE 28.—LEAD MINES OF MISSOURI, ACREAGE OWNED, AND VALUE OF PRODUCT: 1902.

[Compiled from 16th Annual Report of the State Lead and Zinc Mine Inspector of Missouri.]

SIZE OF PROPERTY.	Number of owners.	ACREAGE.		VALUE OF PRODUCT.				
		Total.	Per cent of total.	Total.	Per cent of total.	Per acre.	Lead.	Zinc.
Total[1]	45	90,519	100.0	$4,409,044	100.0	$49	$4,216,692	$192,352
Less than 10 acres	4	19	(2)	11,927	0.3	628	10,064	1,863
10 to 99 acres	18	800	0.9	399,048	9.0	499	253,699	145,349
100 to 999 acres	11	4,292	4.7	504,308	11.4	118	459,168	45,140
1,000 acres and over	12	85,418	94.4	3,493,761	79.3	41	3,493,761	....

[1] Exclusive of lead valued at $117,374 and zinc at $420, produced by operators who did not report acreage.
[2] Less than one-tenth of 1 per cent.

As appears from the preceding table, the title to all lead bearing lands in Missouri were concentrated in the hands of 45 owners, 94 per cent of all the lands being held by 12 owners in tracts of over 1,000 acres. The same properties furnished over three-fourths (77.74 per cent) of the total production. The production per acre decreased with the increase of the acreage, the range being from $628 per acre for the small properties to $41 per acre for the larger ones; this points to the fact that the larger properties are as yet undeveloped.

TABLE 29.—ZINC MINES OF MISSOURI, ACREAGE OWNED, AND VALUE OF PRODUCT: 1902.

[Compiled from 16th Annual Report of the State Lead and Zinc Mine Inspector of Missouri.]

SIZE OF PROPERTY.	Number of owners.	ACREAGE.		VALUE OF PRODUCT.				
		Total.	Per cent of total.	Total.	Per cent of total.	Per acre.	Zinc.	Lead.
Total[1]	147	35,248	100.0	$7,630,402	100.0	$216	$6,685,875	$944,527
Less than 10 acres	17	85	0.2	230,415	3.0	2,711	215,885	14,530
10 to 99 acres	99	4,148	11.8	3,415,367	44.8	823	3,067,548	347,819
100 to 999 acres	25	6,191	17.6	2,625,250	34.4	424	2,271,784	353,466
1 000 acres and over	6	24,824	70.4	1,359,370	17.8	55	1,130,658	228,712

[1] Exclusive of zinc valued at $174,189 and lead valued at $39,564, produced by operators who did not report acreage.

As appears from the above table, over two-thirds of all the zinc bearing lands were owned by 6 companies. The output, however, did not keep pace with the area owned, since only one-sixth of the total output was produced by these 6 companies. With the increase in the size of the property there was a decrease in the production per acre: while the small properties yielded $2,711 per acre, the largest yielded only $55 per acre. This indicates that the greater part of the extensive zinc bearing fields owned by the larger companies is still awaiting development, whereas the small properties are under active operation.

Local observers have noted the connection between the growth of centralization and the progress of deep mining. Shallow mining, which was universal in the past, has given way to deep mining, as shown in the following table compiled from the Report of the State Lead and Zinc Mine Inspector of Missouri:

TABLE 30.—*Depth of shaft and value of product in Missouri: 1902.*

[Compiled from 16th Annual Report of the State Lead and Zinc Mine Inspector of Missouri.]

AVERAGE DEPTH OF SHAFT.	Number of operators or lessees.	VALUE OF PRODUCT.		
		Total.	Per cent of total.	Average per operator.
Total[1]	189	$11,937,186	100.0	$63,160
Less than 100 feet	35	428,520	3.6	12,243
100 to 199 feet	124	6,812,629	57.1	54,940
200 feet and over	30	4,696,037	39.3	156,535

[1] Exclusive of lead and zinc valued at $433,799, produced from mines that did not report the depth of shaft.

It appears from this table that the bulk of the product was obtained from mines over 100 feet in depth; about two-fifths of the production came from mines over 200 feet in depth. The average value per operator increased with the depth of the mine.

Production on a small scale.—There were in 1902 a number of mines operated by means of animal or hand power only. The Report of the State Mine Inspector of Missouri shows that there were in that state 857 shafts equipped with 639 steam hoisters and 265 horse hoisters. Of the 559 mines and mills reported to the Bureau of the Census, 170 were without mechanical power, 355 possessed mechanical power, 16 were custom mills, and 18 failed to report as to their equipment.

Table 31 shows the average production for all mines and for those using hand and animal power only, by states.

TABLE 31.—*Average production for all mines and for those using hand and animal power only, by states: 1902.*

STATE.	AVERAGE VALUE OF PRODUCT PER MINE.	
	All mines.	With hand and animal power only.
United States	$23,199	$2,852
Illinois	6,173	3,897
Iowa	954	1,726
Kansas	6,351	2,557
Missouri	30,285	2,476
Wisconsin	5,263	3,375

The following table shows the distribution of the mines using only hand and animal power, by value of production, and by states:

TABLE 32.—*Number and value of production of mines without mechanical power, by states: 1902.*

PRODUCT PER MINE.	NUMBER OF MINES.				
	United States.	Kansas.	Missouri.	Wisconsin.	All other states[1]
Total	170	20	58	73	19
Less than $500	48	4	20	17	7
$500 to $999	28	4	12	10	2
$1,000 to $9,999	82	11	21	42	8
$10,000 to $49,999	12	1	5	4	2

[1] Includes Illinois and Iowa.

Table 33 is a summary showing expenses and product, by states, for mines using hand and animal power only.

TABLE 33.—SUMMARY FOR MINES OPERATED WITHOUT MECHANICAL POWER, BY STATES: 1902.

STATE.	Number of mines.	Number of owners working.	Salaries.	Wages.	Contract work and work on share of product.	Miscellaneous expenses, exclusive of royalties.	Cost of supplies and materials.	PRODUCT.				
								Total value.	Lead.		Zinc.	
									Short tons.	Value.	Short tons.	Value.
United States	170	170	$19,484	$170,354	$29,365	$4,202	$44,087	$484,800	5,015	$236,911	13,543	$247,889
Illinois	5			10,520			1,041	19,486	110	5,406	700	14,080
Iowa	14	14	280	5,766		556	919	24,158	186	9,106	375	15,052
Kansas	20	64	125	9,299			6,609	51,140	543	23,949	993	27,191
Missouri	58	68	9,363	47,104	28,867	2,752	17,183	143,631	2,375	115,603	1,401	28,028
Wisconsin	73	24	9,716	97,675	498	894	18,335	246,385	1,801	82,847	10,074	163,538

A computation from the figures presented shows an average value of about $47 per ton of lead ore. The average computed for all mines of the same states was about $44. The value per ton of zinc ore realized by the operators using only hand and animal power averaged about $18, and the average computed for all mines of the same states was likewise about $18. This shows that in marketing their ores the small operators enjoyed the same facilities as all other competitors in the lead and zinc market.

The detailed statistics of lead and zinc mining for 1902 are given in Table 34.

DESCRIPTIVE.

The earliest discovery of lead on the American continent is recorded fourteen years after the landing of the first English settlers in Virginia. In 1621 lead deposits were found in the vicinity of Falling creek, near Jamestown. The steady tide of European immigration in the seventeenth and eighteenth centuries caused a growing demand for bullets and stimulated further discoveries wherever the settlements of the colonists extended. The French acquainted the northwestern Indians with firearms, inducing them to hunt fur bearing animals on a large scale: consequently lead assumed a value in the eyes of the Indians, both for use in making bullets for their own weapons and as an article of traffic. Toward the close of the seventeenth century the Indians living in the region comprising portions of the present states of Wisconsin, Illinois, and Iowa, were smelting lead and bartering it with the French traders. In the second half of the eighteenth century lead had become of such importance in the trade of the upper Mississippi country that it served as currency, the rate of exchange being a peck of corn for a peck of ore. In 1810 Nicholas Boilvin, United States Indian agent at Prairie du Chien, went on foot from Rock Island to the mouth of the Wisconsin, and reported that the Indians of the region had "mostly abandoned the chase, except to furnish themselves with meat, and turned their attention to the manufacture of lead."[1]

Previous to the Louisiana purchase nearly all the valuable lead mining lands were within the domains of France and Spain. Soon after these lands had passed under the jurisdiction of the United States, Congress, by the act of March 3, 1807, reserved all Government lands bearing lead ores, and authorized leases of these lands. The first leases provided for a 10 per cent royalty on the lead produced; the rate was afterwards reduced to 6 per cent. No leases were issued until 1822, when crowds of prospectors began to enter this region. A few years later the mines gave employment to over 2,000 men, many of them farmers, who with their slaves spent only their spare time in the mines. The royalties were paid with some regularity for a short time only; after 1834, as a consequence of the immense number of illegal entries of mineral land at the Wisconsin land office, the smelters and miners refused to make any further payments, and the Government was unable to collect any royalty from them. After much trouble and expense, it was, in 1847, finally concluded to sell the mineral lands.[2]

The chief lead mining districts, which to-day furnish the bulk of the lead production of the United States, were not developed until much later. The lead deposits of the Joplin-Galena district, embracing southwestern Missouri and part of Kansas, were discovered in 1848, but attracted little attention before the Civil War. The great western deposits of argentiferous galena were discovered in 1864, but could not be worked profitably until the extension of the railroads through that region.

Methods of mining and smelting.—The early methods of lead mining on this continent were extremely crude. The Indians, who during the time of the French dominion were the chief producers, only skimmed the surface, although occasionally they would drift for some distance into the sidehills, and when they reached rock would build a fire under it and crack it by dashing cold water on the heated surface. Their tools, in the earliest times, were buckhorns, many of which were found in abandoned drifts by the first white settlers, but in the eighteenth century they obtained iron implements from the traders to whom they sold their lead. The Indians loaded their ore in the shafts into tough deerskins, the bundle being hoisted to the surface or dragged up inclined planes by long thongs of hide. Many of these leads, abandoned by the Indians when the work of developing them became too great for their simple tools, were found at a later epoch to be among the most profitable in the region.

Improvement in the method of working the mines was very slow for a long time after the advent of white miners. The first shaft in a lead mine in Missouri was sunk about the beginning of the nineteenth century. Schoolcraft, who visited the lead mining district in 1819, found about 40 mines, 4 or 5 of which had regular shafts. There was not an engine of any kind—horse, steam, or water power—for removing water from the mines, several of which, with the richest prospects in view, had been abandoned on this account.

The reduction of lead ore to the metallic state was in the earliest times not differentiated from mining. Any man who found a vein could mine and smelt the ore roughly himself. The methods of smelting were crude in the extreme. A hole was dug in the ground and lined with rocks. This was usually located on a hillside for the purpose of getting a strong air draft. Hollow log heaps were reared; the centers were filled with mineral; then as much wood as possible was piled on top of and around the heaps, and the mass was fired, with the result that a portion of the ore was smelted and ran into trenches in the ground. Sometimes this operation had to be repeated three times. Rough pigs run into a scooped-out hollow in the earth itself, and weighing about 75 pounds, were usually made by the Indian squaws. This method of smelting was wasteful, but since the supply of ore was apparently unlimited the same practice was followed as late as the first quarter of the nineteenth century by white miners, as well as by operators who worked their mines with slave labor. About that time smelting began to be specialized by ore buyers as a separate occupation. The methods of reduction practiced in those days are thus described by Schoolcraft:

> Having raised a sufficient quantity of ore for smelting, the next process consists in cleaning the ore from all extraneous matter. This is done by small picks, tapered down to such a point that a careful hand may detach the smallest particle of adhering spar. It is necessary that the ore should be well cleaned, for it would otherwise prove refractory in smelting. If there be any lumps of uncommon size, these are beaten smaller. The object is to bring the lumps as near as may be to a uniform size, so that the heat may operate equally in desulphurating the ore. It is desirable that the lumps should be about the bigness of a man's two fists, or about 15 pounds in weight; if too small, a difficulty and a waste is experi-

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[1] Early Lead Mining in Illinois and Wisconsin, by Reuben Gold Thwaites, in Report of American Historical Association, 1893, page 191ff.

[2] Metallic Wealth of the United States, by J. D. Whitney, page 405.

> enced in smelting. In this state the ore is conveyed to the furnace and piled on the logs prepared for its reception. When the charge is put in, which may in a common way be about 5,000 pounds, it is surrounded by logs of wood and covered over at the top and the fire is lit up at the mouth below. A gentle warmth is given at first, which is raised very gradually and kept at this point for about twelve hours to allow the sulphur to dissipate; the heat is then increased for the purpose of smelting the ore, and in twelve hours more the operation is completed and the lead obtained. Wood is occasionally added as the process goes on, and there is a practical nicety required in keeping the furnace in proper order, regulating the draft of air, etc., so that some smelters are much more expert, and thereby extract a greater quantity of lead from a like body of ore than others. This furnace is called the log furnace, and so far as I know, is peculiar to this country. It is of very simple construction, consisting of an inclined hearth, surrounded by walls on three sides, open at top, and with an arch for the admission of air below, and upon the whole it appears well adapted to the present situation and circumstances of the people. It is cheap, simple, may be built at almost any place, and answers the purpose very well. A good furnace of this kind may be built at an expense of from $50 to $60, every expense considered.[1]

It does not seem from this description that the white miners and smelters had by that time made much improvement upon the primitive methods of the Indians. It was not before 1836 that the log furnace was superseded by the blast furnace.

Ignorance of scientific methods caused the early miners to throw away the lead carbonate, or cerussite, which they called "dry bone" and considered worthless. It accumulated in great heaps until the arrival, in 1838, of a German named Hagen, who knew the value of "dry bone," and erected furnaces for its reduction. The result of the utilization of the cerussite was a largely increased production.

Utilization of zinc ore.—The ignorance of the practical miner likewise retarded the utilization of zinc ores, which are associated with lead ores and now constitute the chief value of the output of the zinc-lead mines. The presence of zinc in the lead mines of the Mississippi valley was noted by Schoolcraft, who wrote as early as 1819:

> Considering the rarity of this metal in America, and its extensive usefulness, which is yearly increasing, I have no doubt it will shortly attract the attention of some capitalist and become a source of much profit.[2]

It took, however, more than half a century before the prediction was fulfilled. Whitney, writing thirty-five years later, gave expression to the following view:

> No one acquainted with the manufacture of zinc ores into metal or oxide would recommend the establishment of works for this purpose in the western lead region, as the business can not be made profitable against the competition of the Belgian and Prussian manufactories, except under the most favorable circumstances of situation and an abundant supply of ore which can be obtained without any considerable mining cost. The zinc deposits of the West do not satisfy these conditions either as regards quantity or quality of the ore or of the proximity of fuel.[3]

These words of one who was an expert in his own time have a peculiar sound to-day, when it is considered that over $8,000,000 was won from the western zinc deposits in 1902.

For over half a century zinc ore was taken out of the mines of the southwestern part of Missouri, in connection with lead ore, and thrown upon the dump pile as worthless. Mines were deserted because of the prevalence of this refuse or "tiff," as it was called by the miners. In the early seventies this peculiar looking substance, which was causing the lead miners so much trouble, was examined by a geologist and pronounced to be zinc ore. A carload of it was shipped to Lasalle, Ill., for treatment. The smelter returned $15 for the carload, telling the shippers that it was a high grade of zinc ore. This led to further shipments of the ore. Abandoned mines were gradually reopened because of the zinc ore they contained, and in 1902 the zinc product of Missouri was more than eleven times the value of all the zinc ore mined in the Eastern states, where zinc mining dates back to 1848, and where the mines were the main source of the domestic zinc supply previous to the development of the Joplin-Galena district.

Business organization.—The last twenty years in the history of the lead-zinc mining industry have been a period of change. A contemporaneous description of the business methods of twenty years ago is given in the following excerpts:

> When a good prospect is discovered in new ground the land around it is leased from the original owners on royalties ranging from 10 to 25 per cent by a number of individuals, who organize various mining, or, as they would more properly be called, land companies. These companies have the land divided up into lots 200 feet square, and a plat of it made; select certain lots for themselves, and throw the others open to miners. They usually start a shaft on one of their own lots, and put in a pump. If the indications continue good, many of the lots, particularly those near the pump shaft, are quickly taken up by parties of miners who sink shafts upon them, timber the ground, put up hoisting contrivances, furnish all supplies, and bear all expenses.
>
> When ore is struck it is drifted on and followed in all directions up to the boundaries of the lot in question. The ore is raised to the surface and crushed and washed by the miners, and is sold to one of the zinc or mineral buyers. It is weighed over the company's scales, and paid for to the company, which deducts a royalty of 25 per cent on zinc blende and 50 per cent on "mineral" (galena); and if it has pumps running, a pump rent of $1 a ton on zinc ore and $2 on 1,000 pounds of galena; and pays over the balance to the miners. The royalties, of course, vary with circumstances, but the above are general.[1]

With a few exceptions all the mining was done by small companies, mostly unchartered associations of persons living in the immediate neighborhood. Some storekeeper, farmer, or local capitalist furnished the small amount of money needed for tools; and the men who worked in the ground in winter usually engaged in farm work during the summer. The ore was generally raised to the surface by a windlass, and cleaned by hand with a "pickawee" hammer, or crushed with a "bucking iron" on a flat stone, or by an itinerant horsepower crusher, and was concentrated by sluicing and hand jigging. The holders of lots sometimes put up crushing and washing machinery on their lots.

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[1] View of the Lead Mines, by Henry Rowe Schoolcraft, pages 93 and 94.

[2] Ibid., page 56.

[3] Metallic Wealth of the United States, page 352.

[1] United States Geological Survey, "Mineral Resources of the United States," 1882, pages 369 and 370.

> The machinery is usually of the simplest description—a farm or small stationary engine, covered by a shed of rough boards, a small-sized Blake's breaker, set over a pair of rolls, and a horse whim or a whip. The jigs are ordinary hand jigs, with an overhead breakstaff, working a sieve 2 by 3¼ feet up and down in a box of water. The jigging is usually done by contract, and is paid for by the ton of cleaned ore. It is common to see from 10 to 20 of these jigs grouped together under a shed of poles, covered with branches of trees or rough boards.[1]

The smelting companies which drew their ore supply from this district had their resident or traveling purchasing agents. Most of the miners were poor and unable to work their diggings to good advantage, or to hold their ore long after it was cleaned.

The labor was to a considerable extent performed by miners working upon their own account. Men with no capital but their picks and shovels would lease small mining lots and try their luck. The advantages of the leasing system to the landowner and mine operator, as compared with the regular wage system, are further explained in the same article. The miners, working on their own account, with hopes of large ultimate gains, have every inducement to work hard and cheaply, and to follow every clew that working prospectors, who, during the season wander from place to place, and follow every real or supposed indication of ore, may find.

> How else, it may be asked, could prospecting be so well or so cheaply done? And there is a class of enterprising, skillful, well-to-do miners, naturally associated as partners, who have made one or more good strikes, and are always ready to take hold of any new venture that promises well, either in working a lot or in forming a land company to open new mines. Where else could be found capitalists so willing to risk their money in a speculative venture? Men of this sort are always ready and able to work themselves, or to direct the work above or below ground. How else could be obtained as willing and as watchful superintendents, foremen, and clerks?[2]

The leasing system has maintained itself up to the present day in zinc mining. A comprehensive description of this system is given in a recent pamphlet by a local expert, Mr. Frank Eberle:

> The methods of mining and handling zinc ore are * * * unlike those used in mining for other minerals. The first step necessary is to secure the land upon which to begin operations. Zinc mining lands are seldom sold, their owners preferring to lease them on royalty. Virgin lands, or those on which no mineral has been found, or which have never been prospected for mineral, are leased at 10 per cent royalty, that is to say, the landowner leases the land and agrees to take as payment one-tenth of all the ore obtained from his land. The company or individual who secures the lease then divides the tract up into 1-acre mining lots and prospects the land with a steam drill in several places to ascertain whether the land contains mineral, and where the best bodies of ore are located, their depth, thickness, and the force of water that the miners will have to contend with. When the land has been sufficiently prospected, lots are then subleased to miners at 20 per cent royalty, which means that the miners must give 20 per cent, or one-fifth, of the ore to the company or individual holding the original lease. Out of this 20 per cent the original lessee must pay the landowners 10 per cent, and generally he must also undertake to put in pumping plants, to keep the tract drained, where the water is so strong as to interfere with mining. The miners lease one or more lots from the lessee of the tract, and begin operation by sinking a shaft. * * *
>
> The zinc ore, or "jack," is purchased at the mines by "jack" buyers representing American and European smelters. These buyers * * * bid on the week's output of zinc ore. They make an offer of so much a ton for all of the ore to be taken out of the mine during the week. If the offer is accepted, the "jack" buyer sends his wagons to the mines, and hauls the ore to the cars for shipment to the smelters for which he buys. Every Saturday evening is settling-up time. Then the mine owners, miners, and ore buyers assemble in the various towns in the district, and the ore buyer draws a check for the ore purchased from each mine. The check is made payable to the landowner upon whose property the ore was mined. He takes out his 10 per cent royalty, and passes the balance to the original lease holder, who takes out his 10 per cent royalty and gives the balance to the mine operator, who pays his operating expenses out of the share he receives.[3]

The larger companies which have their own smelters buy all the ore from their lessees at a stipulated price, deducting from the same their royalties.

Mining in a small way.—It is of great theoretical and practical interest to note the special conditions which have permitted of the survival of zinc-lead mining on a small scale, and often with primitive methods, amid concentration of ownership in mineral lands.

The subject is treated from a technical point of view in the Twenty-second Annual Report of the United States Geological Survey, from which the following is quoted:

> The individual ore bodies are rarely large. The mines must accordingly be short lived, and the plants must be built to meet that condition. In a district where it is cheaper to sink a new shaft than to tram ore 600 or 700 feet underground, central shafts of large capacity are out of place. Large central mills to which the ore of a whole tract is brought are not considered a good investment. In hauling 100 tons of 10 per cent ore 90 tons of waste drift are moved, and when simple and effective mills of small capacity are so easily and cheaply built and run, individual mills are to be preferred, even though the larger mill be able to make a slight saving per ton in mill charges. It is difficult to supply dirt steadily enough to keep a large mill running, and loss of time is more costly with a large than a small plant. The mills of the district * * * are very simple, and are developed on the principle of using a rougher jig before cleaning, instead of attempting close sizing. The result is a very great capacity at small cost. The saving is not so close as in a well-run sizing mill, but the extra ore saved by the latter is not in this district worth the added cost

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[1] United States Geological Survey, "Mineral Resources of the United States," 1882, page 370.

[2] Ibid., page 371.

[3] Frank Eberle, Zinc Mining, pages 8 and 20.

of saving it. * * * A hundred-ton mill can be built in the district at a general price of $6,500 to $7,000, and the opening and equipping of a mine costs ordinarily, approximately, $10,000. The mill can be run by four men. To that number must be added a hoisterman and an underground force. * * * The mill and plant are of such style as to be readily torn down and moved when the particular ore body is worked out, and the whole plant is designed for rapid work. Economy is sought in first cost rather than in refinements of efficiency. * * * The whole style of equipment and the methods of mining and milling are designed to meet the conditions of short-lived individual deposits of low-grade ore.[1]

The higher cost of running small plants, as compared with mines operated on a large scale, comes from the expensive methods of generating and distributing power, but it is the opinion of Mr. Bain that, with modern methods of power transmission, this difficulty can be overcome by the development of central power plants.

Though the actual operation of the mines is to some extent still conducted on a small scale, the tendency toward combination has not been without effect upon the zinc-lead mining industry.

Both the productive capacity and the consumptive demand for spelter have been centralized in a striking manner. Upward of 50 per cent of the consumption of spelter in the United States is for the purpose of galvanizing iron, which business is now chiefly in the hands of the constituent companies of the United States Steel Corporation. The manufacture of sheet zinc is in the hands of four companies. The manufacture of brass in Connecticut, which is the principal center of that industry, is controlled by one company. The consumption of spelter for use in the desilverization of lead is also chiefly in the hands of one corporation. It is safe to say, therefore, that 75 or 80 per cent of the demand for American spelter now comes from seven corporations. On the other hand, the production of spelter has also been centralized, practically the whole of the active smelting capacity being now divided among seven concerns.[2]

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[1] Twenty-second Annual Report of the United States Geological Survey, Part II, 1900–1901. Preliminary report on the lead and zinc deposits of the Ozark region, by H. F. Bain, page 227.

[2] Production and Properties of Zinc, pages 46 and 47.

TABLE 34.—DETAILED SUMMARY: 1902.

	United States.	Colorado.	Illinois.	Iowa.	Kansas.	Missouri.	Wisconsin.	All other states and territories.[1]
Number of mines	559	3	14	14	57	374	90	7
Number of operators	557	3	14	14	57	374	90	5
Character of ownership:								
Individual	66	....	4	2	4	48	5	3
Firm	323	2	6	12	44	189	70	....
Incorporated company	159	1	4	....	8	129	15	2
Other form	9	....	....	....	1	8	....	....
Salaried officials, clerks, etc.:								
Total number	910	3	12	1	35	777	50	32
Total salaries	$826,327	$2,025	$9,120	$280	$21,143	$727,021	$26,202	$40,536
General officers—								
Number	76	1	2	....	....	65	....	8
Salaries	$195,910	$500	$1,000	....	....	$176,650	....	$17,760
Superintendents, managers, foremen, surveyors, etc.—								
Number	363	2	7	1	14	289	33	17
Salaries	$365,089	$1,525	$6,870	$280	$11,746	$307,470	$19,294	$17,904
Foremen below ground—								
Number	366	....	1	....	19	329	17	....
Salaries	$209,808	....	$500	....	$8,827	$193,573	$6,908	....
Clerks—								
Number	105	....	2	....	2	94	....	7
Salaries	$55,520	....	$750	....	$570	$49,328	....	$4,872
Wage-earners:								
Aggregate average number	7,881	5	104	13	228	6,612	417	507
Aggregate wages	$4,329,271	$5,475	$51,565	$5,766	$140,249	$3,691,923	$192,209	$242,084
Above ground—								
Total average number	3,443	1	28	6	120	2,845	122	321
Total wages	$1,948,180	$1,125	$14,967	$2,544	$80,203	$1,638,482	$56,924	$153,935
Engineers, firemen, and other mechanics—								
Average number	1,149	1	11	....	36	1,007	27	67
Wages	$727,232	$1,125	$6,310	....	$23,253	$642,665	$13,850	$40,029
Miners—								
Average number	290	....	10	6	7	155	82	30
Wages	$146,373	....	$4,556	$2,544	$4,000	$87,310	$37,064	$10,899
Boys under 16 years—								
Average number	23	....	1	....	....	21	1	....
Wages	$5,644	....	$175	....	....	$5,208	$266	....
All other wage-earners—								
Average number	1,981	....	6	....	77	1,662	12	224
Wages	$1,068,931	....	$3,926	....	$52,950	$903,304	$5,744	$103,007
Below ground—								
Total average number	4,438	4	76	7	108	3,767	295	186
Total wages	$2,381,091	$4,350	$36,598	$3,222	$60,046	$2,053,441	$135,285	$88,149
Miners—								
Average number	3,010	4	74	7	98	2,471	282	74
Wages	$1,679,325	$4,350	$35,753	$3,222	$56,771	$1,413,280	$129,465	$36,484
Miners' helpers—								
Average number	658	....	2	....	5	544	....	107
Wages	$317,050	....	$845	....	$3,275	$264,064	....	$48,866
Boys under 16 years—								
Average number	7	....	....	....	....	7	....	....
Wages	$947	....	....	....	....	$947	....	....
All other wage-earners[2]—								
Average number	763	....	....	....	....	745	13	5
Wages	$383,769	....	....	....	....	$375,150	$5,820	$2,799

[1] Includes operators distributed as follows: Arizona, 1; Kentucky, 1; New Jersey, 1; New Mexico, 1; New York, 1; Virginia (2 mines; operator reported under iron ore).

[2] Includes timbermen and track layers.

TABLE 34.—DETAILED SUMMARY: 1902—Continued.

	United States.	Colorado.	Illinois.	Iowa.	Kansas.	Missouri.	Wisconsin.	All other states and territories.
Average number of wage-earners at specified daily rates of pay:								
Engineers—								
$1.25 to $1.49	2						2	
$1.50 to $1.74	44		5			24	9	6
$1.75 to $1.99	73				2	61	6	4
$2.00 to $2.24	176		3		17	149	5	2
$2.25 to $2.49	85		1		6	78		
$2.50 to $2.74	117				4	111		2
$2.75 to $2.99	5					5		
$3.00 to $3.24	24					24		
$3.50 to $3.74	1							1
$4.00 to $4.24	1	1						
Firemen—								
$1.25 to $1.49	53					53		
$1.50 to $1.74	104		1			100	1	2
$1.75 to $1.99	7					7		
$2.00 to $2.24	41				1	36		4
$2.25 to $2.49	8					8		
$2.50 to $2.74	10					10		
$3.00 to $3.24	1					1		
Machinists, blacksmiths, carpenters, and other mechanics—								
$1.00 to $1.24	1					1		
$1.25 to $1.49	11					11		
$1.50 to $1.74	54		1			37	2	14
$1.75 to $1.99	51				1	41		9
$2.00 to $2.24	159				3	142	2	12
$2.25 to $2.49	49				1	46		2
$2.50 to $2.74	42				1	38		3
$2.75 to $2.99	7					5		2
$3.00 to $3.24	17					16		1
$3.25 to $3.49	3					1		2
$3.50 to $3.74	2					1		1
$3.75 to $3.99	1					1		
Miners—								
$1.00 to $1.24	47					19	2	26
$1.25 to $1.49	300					209	91	
$1.50 to $1.74	909		72	13		529	256	39
$1.75 to $1.99	308				29	227	13	39
$2.00 to $2.24	1,217		11		73	1,131	2	
$2.25 to $2.49	414		1			413		
$2.50 to $2.74	93				3	90		
$2.75 to $2.99	2					2		
$3.00 to $3.24	8	3				5		
$3.25 to $3.49	1					1		
$3.50 to $3.74	1	1						
Miners' helpers—								
$1.00 to $1.24	4					4		
$1.25 to $1.49	302		2			300		
$1.50 to $1.74	183					76		107
$1.75 to $1.99	21				1	20		
$2.00 to $2.24	124				4	120		
$2.25 to $2.49	24					24		
Timbermen and track layers—								
$1.25 to $1.49	11					11		
$1.50 to $1.74	7					5		2
$1.75 to $1.99	3							3
$2.00 to $2.24	13					13		
$2.25 to $2.49	1					1		
$3.00 to $3.24	1					1		
Boys under 16 years—								
Less than $0.50	5					5		
$0.50 to $0.74	12					11	1	
$0.75 to $0.99	5					5		
$1.00 to $1.24	5		1			4		
$1.25 to $1.49	1					1		
$1.50 to $1.74	2					2		
All other wage-earners—								
$0.50 to $0.74	2							2
$0.75 to $0.99	2							2
$1.00 to $1.24	108					78		30
$1.25 to $1.49	691				1	589	4	97
$1.50 to $1.74	750				2	680	15	53
$1.75 to $1.99	220		5		10	201	4	
$2.00 to $2.24	571				39	490	2	40
$2.25 to $2.49	207					207		
$2.50 to $2.74	47				4	43		
$2.75 to $2.99	12					12		
$3.00 to $3.24	92		1		18	73		
$3.25 to $3.49	6				3	3		
Average number of wage-earners employed during each month:								
Men 16 years and over—								
January	7,325		97	12	175	6,135	445	461
February	7,266		94	16	167	6,153	415	421
March	7,465		96	16	187	6,277	427	462
April	7,608		111	13	209	6,415	393	467
May	7,965	20	115	16	207	6,726	364	517
June	7,996	20	124	9	197	6,750	398	508
July	8,006	20	82	7	227	6,766	390	516
August	8,181		98	9	238	6,890	407	539
September	8,067		114	16	258	6,689	437	553
October	8,125		92	12	270	6,729	463	559
November	8,034		82	13	273	6,710	431	525
December	8,172		131	17	268	6,768	432	556
Boys under 16 years—								
January	27		2			25		
February	27		2			25		
March	28		2			26		
April	28		2			26		
May	31		2			26	3	
June	32		2			27	3	
July	35					32	3	
August	31					30	1	
September	32					31	1	
October	32					31	1	
November	27					27		
December	30					30		

TABLE 34.—DETAILED SUMMARY: 1902—Continued.

	United States.	Colorado.	Illinois.	Iowa.	Kansas.	Missouri.	Wisconsin.	All other states and territories.
Contract work:								
Amount paid	$108,607	$800			$922	$105,877	$1,008	
Number of employees	223	4			11	198	10	
Miscellaneous expenses:								
Total	$2,091,891	$400	$11,079	$2,511	$151,279	$1,768,458	$54,534	$103,630
Royalties and rent of mine and mining plant	$1,525,368		$9,853	$1,955	$140,736	$1,235,753	$52,876	$84,195
Rent of offices, taxes, insurance, and all other sundries	$566,523	$400	$1,226	$556	$10,543	$532,705	$1,658	$19,435
Cost of supplies and materials	$2,511,657	$3,000	$20,464	$919	$84,311	$2,189,461	$56,774	$156,728
Value of product	[1] $14,640,177	$22,398	$90,619	$15,378	$737,656	$12,555,590	$473,672	$706,911
Power:								
Total horsepower	41,901	70	412		2,512	35,680	846	2,381
Owned—								
Engines—								
Steam—								
Number	1,060	1	14		92	907	25	21
Horsepower	38,616	50	364		2,512	32,953	617	2,120
Gas or gasoline—								
Number	32	1	4			6	17	4
Horsepower	431	20	48			113	229	21
Water wheels—								
Number	8					3		5
Horsepower	320					80		240
Other power—								
Number	39					39		
Horsepower	2,335					2,335		
Rented—								
Electric, horsepower	7					7		
Other power, horsepower	192					192		
Electric motors owned—								
Number	45		4		2	32	2	5
Horsepower	1,475		39		35	1,167	12	222
Supplied to other establishments, horsepower	91				30	61		

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[1] Includes $1,965,779 for which no individual reports were received.

COPPER ORE

COPPER ORE.

By Isaac A. Hourwich, Ph. D.

The statistics for copper ore in this report are those of mines producing ores, the principal or only value of which is their copper contents. The statistics for ore dressing works (stamp mills and concentrating plants) connected with copper mines are included in the returns. Copper is recovered also as a by-product of the smelting of ores valued chiefly for their precious metal contents. All statistics relating to the mining of these ores are included in the returns for gold and silver mines. Smelters are regarded as manufacturing establishments and were included in the Report on Manufactures of the Census of 1900.

The following table is a comparative summary of the statistics of copper mines from 1860 to 1902:

Table 1.—COMPARATIVE SUMMARY: 1860 TO 1902.

	1902	1890[1]	1880	1870	1860
Number of mines	144	(2)	42	[3] 10	[3] 47
Number of operators	144	(2)	(2)	(2)	(2)
Salaried officials, clerks, etc.:					
Number	1,208	[4] 70	219	(2)	(6)
Salaries	$1,768,456	$123,236	(2)	(2)	(6)
Wage earners:					
Average number	26,007	19,730	6,033	5,404	3,186
Wages	$21,151,405	$6,610,781	[5] $3,214,003	$2,706,264	$1,816,160
Contract work	$188,768	$337,061	(2)	(2)	(2)
Miscellaneous expenses	$1,397,465	$1,832,758	(2)	(2)	(2)
Cost of supplies and materials	$11,063,175	$5,638,094	$1,391,825	$586,844	$500,814
Product:					
Quantity of ore mined, short tons	11,780,064	5,622,742	1,007,890	(2)	(2)
Copper contents of ore shipped and milled, pounds	625,404,529	250,969,158	[illegible]	(2)	(2)
Value at mine of ore shipped and milled	$51,178,036	(2)	[7] $8,886,880	$8,204,312	$3,361,222

[1] Detailed figures shown only for Michigan, Montana, Arizona, and New Mexico.
[2] Not reported.
[3] Establishments.
[4] Foremen included in wage earners.
[5] Not reported separately.
[6] Salaries included in wages.
[7] Value of 5,410,536 pounds of copper for Western states and 153,880 pounds for Tennessee not reported.

During the forty-two years covered by the table the growth of copper mining has been very marked, the value of products having increased $47,816,814, or over fourteenfold. The increase in the total wages was $19,335,245, or nearly elevenfold.

It was found that in most of the active mines no separate account was kept for development work. The expenses of producing mines, therefore, include the cost of development work incidental to mining. Considerable development work was done in mines that reported no production. Most of them were located in the Western states, where the mineralogical character of the ore was described as auriferous and argentiferous copper, yet it would not be practicable to classify such mines as copper, or gold and silver mines, in accordance with the chief valuable element of the ore, before they have become regular producers. In most cases the work was prosecuted in the expectation of developing a gold and silver mine. All such mines were, therefore, classed as gold and silver mines. Distinctively copper mines in the development stage were reported from the following states: Michigan, 10 mines; Wisconsin, Maryland, Georgia, Tennessee, and Missouri, 1 mine each. The statistics for these mines are not included in the preceding summary for producing mines, but are presented separately in the following statement:

Development work: 1902.

Number of mines	15
Number of operators	15
Salaried officials, clerks, etc.:	
Number	55
Salaries	$64,298
Wage earners:	
Average number	912
Wages	$484,424
Contract work	$20
Miscellaneous expenses	$48,730
Cost of supplies and materials	$135,847

Number of mines and operators.—The terms "mine" and "operator," as used in this report, require a word of explanation. In some cases certain properties were combined by the owner under one management and reported as one mine, while others were operated as separate mines and so reported. When a "group" of mines was included in one report, it was very largely a matter of opinion whether all or some of the properties constituting the group were to be considered as separate mines, or whether all properties had been merged into one mine. The only reliable unit of enumeration was the reporting corporation, firm, or individual. Among these were 2 corporations whose mines were operated by lessees and 1 holding company, the Amalgamated Copper Company. The capitalization of the first two was a distinct element of the capital invested in copper mining, quite independent of the capital invested by the lessee, and it was believed, therefore, that this ought to be included in the total capitalization reported for the copper mining industry. As regards the Amalgamated Copper Company, it is a matter of opinion whether it or the companies whose entire stock is owned by it should be regarded as the actual operators. It was therefore thought preferable to show in the tables the total number of companies reporting. If the holding company and the two lessors are excluded from the total number reporting, then the number of operators was 141. If, on the other hand, the constituent companies of the Amalgamated Copper Company are excluded, then the total number of operators was 136.

Character of ownership.—The corporate form of ownership was the predominating type in the copper mining industry. Of the 144 operators 100 were incorporated companies, 23 were firms or limited partnerships, 19 were individuals, 1 was a cooperative association, and 1 was an estate. In Michigan all copper mining operators were incorporated.

A summary of all copper mines, classified by character of ownership, is presented in Table 2.

TABLE 2.—*Summary, by character of ownership: 1902.*

	Total.	Individual.	Firms, etc.[1]	Incorporated companies.
Number of operators	144	19	25	100
Salaries	$1,768,456	$27,095	$23,395	$1,717,966
Wages	$21,151,405	$434,069	$138,048	$20,579,288
Contract work	$188,768	$1,100	$4,100	$183,568
Miscellaneous expenses	$1,397,465	$31,084	$7,620	$1,358,761
Cost of supplies and materials	$11,083,175	$202,516	$70,693	$10,809,966
Ore shipped and milled:				
Short tons	11,464,868	156,833	11,178	11,296,857
Value at mine	$51,178,036	$594,377	$161,822	$50,421,837
Bullion contents—				
Copper—				
Pounds	625,004,529	10,388,143	2,060,802	612,555,584
Value	$70,175,810	$919,094	$207,783	$69,048,933
Silver	$5,833,256	$333,932	$52,400	$5,466,924
Gold	$1,854,025	$67,823	$3,929	$1,782,273
Other metals	$19,075	$489	$800	$17,786
Total gross value	$77,882,166	$1,321,338	$244,712	$76,316,116
Crude ore sold	$5,791,928	$968,786	$227,554	$4,595,588
Dressed ore sold	$8,615,960	$315	$4,230	$8,611,415
Ore smelted	$63,474,278	$352,237	$12,928	$63,109,113

[1] Includes 2 mines classed under "other forms."

It appears from the preceding table that the share contributed by each class of operators to the output of the mines was as follows: Incorporated companies, $50,421,837, or 98.5 per cent; individuals, $594,377, or 1.2 per cent; firms, $161,822, or three-tenths of 1 per cent. About three-fourths of the copper ore mined by individuals and firms was sold in the crude state, the remaining one-fourth being dressed or smelted at the mine. The incorporated companies, on the contrary, sold only 6 per cent of their ore in the crude state, namely, a product valued at $4,595,588; the value of dressed ore sold by them was $8,611,415, or 11.3 per cent, and that of ore smelted at the mine or shipped to smelters operated by the same companies was $63,109,113, or 82.7 per cent.

Capital stock of incorporated companies.—The capitalization of the incorporated companies is shown in Table 3. In the consideration of the capitalization of the copper mining companies, it should be borne in mind that a portion of the capital stock of some of them represented the value of smelting plants owned and operated by the same companies.

TABLE 3.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Arizona.	California.	Colorado.	Idaho.	Michigan.	Montana.	Nevada.
Number of incorporated companies	100	21	4	13	1	20	14	1
Capital stock and bonds issued	$378,315,800	$31,302,493	$9,416,597	$7,735,585	$2,000,000	$46,453,750	$253,548,400	$86,500
Capital stock:								
Total authorized—								
Number of shares	45,218,707	8,690,000	1,250,000	10,951,000	200,000	1,960,000	6,395,000	200,000
Par value	$441,788,125	$33,780,000	$10,633,125	$9,965,000	$2,500,000	$49,000,000	$299,625,000	$100,000
Total issued—								
Number of shares	32,390,560	6,911,026	1,000,020	8,086,500	150,000	1,908,150	5,704,194	173,000
Par value	$372,240,270	$28,302,963	$9,416,597	$7,735,585	$1,500,000	$46,453,750	$251,547,400	$86,500
Dividends paid	$14,116,002	$3,667,036	$291,990	$7,000		$3,290,000	$6,325,976	
Common—								
Authorized—								
Number of shares	42,318,707	8,690,000	1,000,000	8,851,000	200,000	1,960,000	6,345,000	200,000
Par value	$429,321,625	$33,780,000	$5,766,625	$7,865,000	$2,500,000	$49,000,000	$294,625,000	$100,000
Issued—								
Number of shares	31,105,560	6,911,026	750,020	7,101,500	150,000	1,908,150	5,654,194	173,000
Par value	$361,388,770	$28,302,963	$4,550,097	$6,750,585	$1,500,000	$46,453,750	$246,547,400	$86,500
Dividends paid	$13,667,012	$3,667,036				$3,290,000	$6,175,976	
Preferred—								
Authorized—								
Number of shares	2,900,000		250,000	2,100,000			50,000	
Par value	$12,466,500		$4,866,500	$2,100,000			$5,000,000	
Issued—								
Number of shares	1,285,000		250,000	985,000			50,000	
Par value	$10,851,500		$4,866,500	$985,000			$5,000,000	
Dividends paid	$448,990		$291,990	$7,000			$150,000	
Bonds:								
Authorized—								
Number	303,950	300,000			500		2,800	
Par value	$6,950,000	$3,000,000			$500,000		$2,800,000	
Issued—								
Number	303,029	299,953			500		2,001	
Par value	$6,075,530	$2,999,530			$500,000		$2,001,000	
Interest paid	$174,500				$30,000		$132,000	
Assessments levied	$7,725,748	$132,400				$7,368,348		

	New Mexico.	North Carolina.	Oregon.	Tennessee.	Utah.	Virginia.	Washington.	Wisconsin.	Wyoming.
Number of incorporated companies	6	1	2	2	11	1	1	1	1
Capital stock and bonds issued	$8,924,960	$3,000,000	$2,500,000	$4,875,000	$6,822,515	$10,000		$1,000,000	$640,000
Capital stock:									
Total authorized—									
Number of shares	6,800,000	300,000	30,007	200,000	3,702,500	200	3,500,000	40,000	1,000,000
Par value	$12,100,000	$3,000,000	$3,700,000	$5,000,000	$6,875,000	$10,000	$3,500,000	$1,000,000	$1,000,000
Total issued—									
Number of shares	3,639,960	300,000	18,007	175,000	3,644,503	200		40,000	640,000
Par value	$8,849,960	$3,000,000	$2,500,000	$4,375,000	$6,822,515	$10,000		$1,000,000	$640,000
Dividends paid					$534,000				
Common—									
Authorized—									
Number of shares	6,800,000	300,000	30,007	200,000	3,702,500	200	3,000,000	40,000	1,000,000
Par value	$12,100,000	$3,000,000	$3,700,000	$5,000,000	$6,875,000	$10,000	$3,000,000	$1,000,000	$1,000,000
Issued—									
Number of shares	3,639,960	300,000	18,007	175,000	3,644,503	200		40,000	640,000
Par value	$8,849,960	$3,000,000	$2,500,000	$4,375,000	$6,822,515	$10,000		$1,000,000	$640,000
Dividends paid					$534,000				
Preferred—									
Authorized—									
Number of shares							500,000		
Par value							$500,000		
Issued—									
Number of shares									
Par value									
Dividends paid									
Bonds:									
Authorized—									
Number	150			500					
Par value	$150,000			$500,000					
Issued—									
Number	75			500					
Par value	$75,000			$500,000					
Interest paid				$12,500					
Assessments levied					$225,000				

As shown in Table 3, the division of stock into common and preferred is not general with copper mining companies. There were only 6 companies reporting both common and preferred stock; up to the close of the year 1902, 1 of these had issued no stock of either kind. The issue of bonds was not favored generally by copper mining companies; there were only 6 companies having bonded indebtedness, and of the $6,950,000 of bonds authorized, $6,075,530 were issued. Assessments on stock were also unusual, the total amount levied by all companies since organization being only $7,725,748.

The following table shows each class of capital stock, authorized and issued, in detail:

TABLE 4.—INCORPORATED COMPANIES, GROUPED BY CLASS OF STOCK: 1902.

CLASS OF STOCK REPORTED.	Number of incorporated companies.	AUTHORIZED.			ISSUED.		
		Total	Common	Preferred.	Total	Common	Preferred
Total	100	$441,788,125	$429,321,625	$12,466,500	$372,240,270	$361,388,770	$10,851,500
Both common and preferred	[1]16	92,833,125	80,366,625	12,466,500	56,816,597	45,965,097	10,851,500
Common only	84	348,955,000	348,955,000		315,423,673	315,423,673	

[1] One company had issued no common or preferred stock up to the close of 1902.

The capital stock shown in Table 3 includes a duplication since the capitalization of the Amalgamated Copper Company, as well as that of its constituent companies, is reported. Table 5 shows the capitalization of the Amalgamated Copper Company and each of its constituent copper mining companies. Neither the parent company nor any of its constituent companies has preferred stock. The Amalgamated Copper Company owns the entire capital stock of the Colorado Smelting and Mining Company, and of the Washoe Copper Company, and a controlling interest in the others.

TABLE 5.—CAPITALIZATION OF THE AMALGAMATED COPPER COMPANY AND ITS CONSTITUENT COMPANIES: 1902.

COMPANY.	COMMON STOCK.				BONDS.			
	Authorized		Issued.		Authorized		Issued	
	Shares	Par value	Shares	Par value.	Number	Par value.	Number	Par value
Amalgamated Copper Company	1,550,000	$155,000,000	1,538,880	$153,888,000				
Anaconda Copper Mining Company	1,200,000	30,000,000	1,200,000	30,000,000				
Boston and Montana Consolidated Mining Company	150,000	3,750,000	150,000	3,750,000	1,500	$1,500,000	61	$61,000
Butte and Boston Consolidated Mining Company	200,000	2,000,000	200,000	2,000,000	1,400	1,400,000	1,394	1,394,000
Colorado Smelting and Mining Company	100,000	1,000,000	100,000	1,000,000				
Parrot Silver and Copper Company	250,000	2,500,000	229,850	2,298,500				
Washoe Copper Company	300,000	30,000,000	30,163	3,016,300				

Dividends.—The total amount of dividends paid in 1902 was $14,116,002. Of this amount, $3,077,760 was paid by the Amalgamated Copper Company. These dividends were derived partly from the dividends declared by its constituent companies, and partly from the earnings of other properties of the Amalgamated Copper Company, such as coal mines, railways, etc. The following table shows the capitalization and dividends of all dividend paying companies, with the exception of the Amalgamated Copper Company, and also the capitalization of the companies that paid no dividends in 1902:

TABLE 6.—INCORPORATED COMPANIES, CLASSIFIED WITH RELATION TO DIVIDENDS, CAPITAL STOCK, AND BONDS: 1902.[1]

	CAPITAL STOCK AND BONDS.						
	Authorized.			Issued.			
	Number of shares or bonds.	Par value.		Number of shares or bonds.	Par value.		Dividends or interest paid.
		Total	Average per share or bond.		Total	Average per share or bond.	
Dividend paying companies—							
Total capitalization	6,963,800	$167,783,125		5,402,731	$116,963,127		$11,080,242
Common stock	5,202,500	152,516,625	$29.32	4,117,277	102,911,127	$24.99	10,589,252
Preferred stock	1,400,000	10,966,500	7.83	985,000	10,551,500	10.71	448,990
Bonds	361,300	4,300,000	11.90	300,454	3,500,500	11.65	42,000
Companies by which no dividends were paid in 1902—							
Total capitalization	37,068,857	125,955,000	3.40	25,751,278	107,464,313	4.17	132,500
Common stock	35,566,207	121,805,000	3.42	25,448,703	104,589,313	4.11	
Preferred stock	1,500,000	1,500,000	1.00	300,000	300,000	1.00	
Bonds	2,650	2,650,000	1,000.00	2,575	2,575,000	1,000.00	132,500

[1] Exclusive of the Amalgamated Copper Company.

There were 18 dividend paying companies, with capital stock issued to the value of $113,462,927; whereas 81 companies, with capital stock issued to the value of $104,889,343, declared no dividends. Dividends on $10,551,500 of preferred stock were declared by 4 companies; the rate of dividends averaged 4.3 per cent. No dividends were declared by these companies on their common stock, which was issued to the amount of $45,965,097. Two companies with preferred stock authorized declared no dividends; the authorized preferred stock of these companies was $1,500,000; the amount issued, $300,000.

Dividends on common stock were declared by 14 companies with an authorized capitalization of $75,150,000, of which $56,946,330 was outstanding; no preferred stock was authorized by these companies. The average rate of dividends on common stock was 18.6 per cent.

A comparison between the par values of dividend paying and nondividend paying stocks is not without interest. The average par value per share of dividend paying common stock was $21.07, whereas the average par value of a share of common stock on which no dividends were declared was only $4.11. Similarly, the par value per share of preferred stock was $10.71 for dividend paying and only $1 for nondividend paying companies. It is apparent that the type of mining enterprises, for which capital stock is issued at $1 and less per share, is more frequent among nondividend paying than among dividend paying companies. The latter are, for the most part, concerns the capital stock of which is issued at prevailing commercial values per share, viz. at $25 and over.

The following statement shows the stock and bonds on which dividends and interest were paid:

Classes of stock and bonds on which dividends and interest were paid: 1902.

CLASS.	Number of companies.	Authorized	Issued	Dividends or interest paid	Per cent.
Common stock	14	$75,150,000	$56,946,330	$10,589,252	18.6
Preferred stock	4	10,966,500	10,551,500	438,990	4.3
Bonds	4	3,800,000	3,001,000	174,500	5.8

The total amount of interest paid on bonds was $174,500, of which $132,500 was paid by companies that declared no dividends in 1902. The rate of interest on bonds averaged 5.8 per cent.

A number of corporations operated both copper mines and smelters, and some were interested in other properties, such as coal or iron mines, railways, etc. The dividends reported for such companies were derived from all those sources and can not be segregated.

A comparative summary of dividend paying companies—with the exception of the Amalgamated Copper Company, which, being merely a holding company, is therefore excluded—and those which declared no dividends in 1902, is presented in Table 7.

TABLE 7.—*Comparative summary of dividend paying and nondividend paying companies: 1902.*[1]

	Total.	Dividend paying companies.	Nondividend paying companies.
Number of companies	99	18	81
Salaries	$1,712,306	$724,774	$987,532
Wages	$20,579,228	$10,357,623	$10,221,605
Contract work	$183,568	$92,384	$91,184
Miscellaneous expenses	$1,358,761	$512,955	$845,806
Cost of supplies and materials	$10,809,966	$6,163,479	$4,646,487
Ore shipped and milled:			
Short tons	11,296,857	5,762,972	5,533,885
Value of product at mine, total	$50,421,837	$32,605,752	$17,816,085
Average per company	$509,311	$1,826,589	$216,583
Bullion contents—			
Copper—			
Pounds	612,555,284	383,894,605	228,660,679
Value	$69,048,963	$43,235,673	$25,813,290
Silver	$5,466,924	$2,849,871	$2,617,053
Gold	$1,782,273	$1,166,286	$615,987
Other metals	$17,986	$15,527	$2,459
Total gross value	$76,316,116	$47,267,337	$29,048,779
Average per ton	$6.75	$8.20	$5.25
Crude ore sold	$4,595,588	$2,617,567	$1,978,021
Dressed ore sold	$8,611,415	$903,074	$7,708,341
Ore smelted	$63,109,113	$43,746,696	$19,362,417

[1] Exclusive of the Amalgamated Copper Company, which is merely a holding company.

It must be borne in mind that the payment of dividends in a given year is not indicative of profits earned during that year. Dividends may be declared from the accumulated surplus of former years. On the other hand, the failure to declare a dividend does not necessarily show a loss; the earnings may have been invested in development work, in new equipment for the plants, in acquiring new property, etc. Some of the principal copper mining companies are close corporations, the stock of which is held by a limited number of persons. As the shares are not on the market, it is often a matter of indifference to the stockholders whether a dividend is declared or the net earnings are accumulated as a surplus.

The chief differences disclosed by the preceding table between the dividend paying corporations and those which paid no dividends in 1902 are as follows:

First. The grade of ore mined was higher with the former than with the latter, viz. $8.20 per ton as against $5.25 per ton.

Second. Where dividends were paid the ore was nearly all smelted at works connected with the mines, whereas in other cases much of the ore was sold.

Third. The average value of product per dividend paying company was $1,826,589, while the average for other companies was only $216,583; apparently it was the largest companies that declared dividends in 1902.

The census returns for 1902 cover a year of low prices of copper. A comparison with the dividends for previous years will be found on a subsequent page, in connection with a study of prices.

Employees and wages.—Wage-earners constituted 95.6 per cent of the total number of employees, and their wages were 92.3 per cent of the total salaries and wages. Table 8 shows, by states and territories, the average number of men, and of boys under 16 years of age, employed during each month.

TABLE 8.—AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH: 1902.

	United States.	Arizona.	California.	Colorado.	Michigan.	Montana.	New Mexico.	Utah.	All other states and territories.
Men 16 years and over									
January	24,895	3,554	384	117	13,832	5,603	111	555	742
February	24,658	3,519	345	112	13,257	6,102	121	514	698
March	25,602	3,702	387	124	13,679	6,393	141	498	701
April	26,088	3,686	482	129	14,118	6,304	160	503	706
May	27,073	3,941	543	124	14,512	6,567	146	513	727
June	26,466	3,937	585	117	13,952	6,538	173	513	651
July	26,829	3,851	635	118	14,249	6,650	147	528	651
August	25,848	3,867	664	117	13,700	6,168	182	493	657
September	25,696	3,711	659	113	13,660	6,317	161	487	587
October	26,273	3,742	611	115	13,973	6,585	212	430	605
November	25,720	3,665	434	97	13,400	6,888	212	406	578
December	25,639	3,796	223	97	13,711	6,615	202	404	591
Boys under 16 years of age									
January	111	50			44				17
February	110	50			43				17
March	113	50			45				18
April	113	50			47				16
May	110	50			43				17
June	106	50			39				17
July	112	51			44				17
August	92	48			27				17
September	92	51			27				14
October	93	50			29				14
November	91	50			27				14
December	93	50			29				14

The average number of wage-earners was greatest, 27,183, in May, and least, 24,768, in February; the variation during the year was not marked.

In the following table the average number of wage-earners at certain specified rates of pay is shown for the various classes of employees, and also the percentage which the number at each rate forms of the total number in the class:

TABLE 9.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	All occupations.		Engineers.		Firemen		Machinists, blacksmiths, carpenters, and other mechanics.		Miners.		Miners' helpers.		Timbermen and track layers.		Boys under 16 years.		All other wage-earners.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	¹26,007	100.0	552	100.0	487	100.0	1,819	100.0	¹12,821	100.0	1,257	100.0	863	100.0	103	100.0	8,105	100.0
0.50 to 0.74	29	0.1									3	0.2			12	11.7	14	0.2
0.75 to 0.99	49	0.2							24	0.2					8	7.8	17	0.2
1.00 to 1.24	201	0.8	2	0.4	1	0.2	3	0.2	1	²	110	8.8	6	0.7	20	19.4	58	0.7
1.25 to 1.49	368	1.4	29	5.3	9	1.8	10	0.5	61	0.5	88	7.0			34	33.0	137	1.7
1.50 to 1.74	1,847	7.1	10	1.8	10	2.1	32	1.8	36	0.3	77	6.1	14	1.6	7	6.8	1,661	20.5
1.75 to 1.99	3,354	12.9	27	4.9	78	16.0	90	4.9	137	1.1	498	39.6	95	11.0			2,430	30.0
2.00 to 2.24	6,277	24.1	74	13.4	119	24.4	233	12.8	3,216	25.1	335	26.7	359	41.6	12	11.7	1,928	23.8
2.25 to 2.49	2,066	8.0	43	7.8	4	0.8	137	7.5	1,309	10.2	50	4.0	53	6.1	10	9.7	458	5.6
2.50 to 2.74	2,285	8.8	35	6.3	99	20.3	260	14.3	1,679	13.1	30	2.4	32	3.7			150	1.9
2.75 to 2.99	661	2.5	62	11.2	8	1.7	58	3.2	368	2.9	10	0.8	3	0.3			152	1.9
3.00 to 3.24	961	3.7	21	3.8	20	4.1	173	9.5	374	2.9	18	1.4	28	3.3			327	4.0
3.25 to 3.49	131	0.5	8	1.5	1	0.2	49	2.7	7	²			21	2.4			45	0.5
3.50 to 3.74	6,742	25.9	25	4.5	134	27.5	227	12.5	5,552	43.3	38	3.0	207	24.0			559	6.9
3.75 to 3.99	54	0.2	10	1.8	2	0.4	24	1.3	1	²			17	2.0				
4.00 to 4.24	605	2.3	167	30.3	2	0.4	273	15.0	40	0.3			26	3.0			97	1.2
4.25 and over	377	1.5	39	7.0			250	13.7	16	0.1							72	0.9

¹Includes 2,296 miners, all in Michigan, who were paid in accordance with the amount of work done; for these the figures shown in this table represent average daily earnings.

²Less than one-tenth of 1 per cent.

The range of wages for the bulk of the employees was from $1.50 to $3.74, 24,324 wage-earners, or 93.5 per cent of the total number, being included between those rates. Practically all those classed as miners were paid at least $2 per day, and 5,552 of them, or 43.3 per cent, received between $3.50 and $3.74. Most of the highly paid miners were reported from Montana and Arizona. Of those classed as miners' helpers, 1,257 in all, 66.3 per cent were paid between $1.75 and $2.24, 22.1 per cent having received less than $1.75, and 11.6 per cent, $2.25 or over. There was a wide range in the rates paid to timbermen and track layers; 454, or 52.6 per cent of the total number, were paid between $1.75 and $2.24, and 24 per cent, from $3.50 to $3.74. Practically all of the timbermen and track layers at $3.50 or over were reported from Montana.

There was also a wide range in the rates for engineers, firemen, machinists, and other mechanics. In each of these three classes more than 90 per cent of the wage-earners received $1.75 per day or over. The proportion receiving $3.50 or over was as follows: Engineers, 43.6 per cent; firemen, 28.3 per cent; and machinists and other mechanics, 42.6 per cent. In each case the greatest number at rates of $3.50 or over were reported from Montana and Arizona.

The number of boys under 16 years employed was small, only 103, or less than five-tenths of 1 per cent, having been reported. Their rates varied from 50 cents to $2.49 a day. Of the 103 boys, 50 were employed in Arizona and 37 in Michigan.

The 8,105 employees grouped under "all other wage-earners" constituted 31.2 per cent of the total number. Their duties were so varied as to render impossible any separation into well-defined occupations. The rates of pay for the greater portion of these wage-earners ranged from $1.50 to $2.24 per day, 74.3 per cent being included between those rates.

The following table shows the distribution of wage-earners according to daily rates of pay, by states:

TABLE 10.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY STATES: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			ARIZONA.			MICHIGAN.			MONTANA.			ALL OTHER STATES.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	[1]26,007	100.0	....	3,797	100.0	....	[1]13,887	100.0	....	6,388	100.0	....	1,935	100.0	....
0.50 to 0.74	29	0.1	100.0	....	....	....	1	(2)	100.0	....	....	....	28	1.4	100.0
0.75 to 0.99	49	0.2	99.9	....	....	....	8	0.1	99.9	....	....	....	41	2.1	98.6
1.00 to 1.24	201	0.8	99.7	18	0.5	100.0	162	1.2	99.9	....	....	....	21	1.1	96.5
1.25 to 1.49	368	1.4	98.9	24	0.6	99.5	197	1.4	99.7	....	....	....	147	7.6	95.4
1.50 to 1.74	1,847	7.1	97.5	47	1.2	98.9	1,652	11.9	97.3	....	....	....	148	7.6	87.8
1.75 to 1.99	3,354	12.9	90.4	580	15.3	97.7	2,705	19.5	85.4	....	....	....	69	3.6	80.2
2.00 to 2.24	6,277	24.1	77.5	346	9.1	82.4	5,806	41.8	65.9	12	0.2	100.0	114	5.9	76.6
2.25 to 2.49	2,066	8.0	53.4	597	15.7	73.3	1,381	9.9	24.1	9	0.1	99.8	79	4.1	70.7
2.50 to 2.74	2,282	8.8	45.4	195	5.1	57.6	1,700	12.2	14.2	33	0.5	99.7	354	18.3	66.6
2.75 to 2.99	661	2.5	36.6	155	4.1	52.5	138	1.0	2.0	....	....	99.2	368	19.0	48.3
3.00 to 3.24	961	3.7	34.1	331	8.7	48.4	106	0.8	1.0	229	3.6	99.2	295	15.2	29.3
3.25 to 3.49	131	0.5	30.4	84	2.2	39.7	7	0.1	0.2	10	0.2	95.6	30	1.6	14.1
3.50 to 3.74	6,742	25.9	29.9	1,176	31.0	37.5	2	(2)	0.1	5,347	83.7	95.4	217	11.2	12.5
3.75 to 3.99	54	0.2	4.0	45	1.2	6.5	4	(2)	0.1	5	0.1	11.7	....	....	1.3
4.00 to 4.24	605	2.3	3.8	158	4.2	5.3	11	0.1	0.1	415	6.5	11.6	21	1.1	1.3
4.25 and over	377	1.5	1.5	41	1.1	1.1	5	(2)	(2)	328	5.1	5.1	3	0.2	0.2

[1] Includes 2,296 miners paid in accordance with the amount of work done; for these only average daily earnings were obtained.
[2] Less than one-tenth of 1 per cent.

Only Arizona, Michigan, and Montana are shown separately. These 3 states gave employment to 24,072 wage-earners, or 92.6 per cent of the total number employed in mines, the principal product of which was copper ore. Of the 3 states, Montana shows by far the highest rates, 6,095 wage-earners, or 95.4 per cent of the total number, receiving $3.50 per day or over. In Arizona 37.5 per cent of the wage-earners received $3.50 or over per day, and 40.1 per cent from $1.75 to $2.49. In Michigan the wages paid were much lower than in either Arizona or Montana, practically all of the men employed in copper mines in that state receiving between $1.50 and $2.74.

The 1,935 wage-earners grouped under "all other states" are distributed among 13 states, no single state reporting as many as 500.

The tenacity of antiquated forms of industrial relations is exemplified in the few copper mines where labor was performed on a share of the product. This form of employment is frequently found in gold mines, where the miners so employed are locally known as "leasers," "tributers," etc. There were only 7 cases of this kind reported at copper mines, namely, 4 in Montana, of which 3 were in Silverbow county; 2 in Arizona; and 1 in Colorado. In all, 22 men besides the regular wage-earners found employment on such terms in these mines. The total output was valued at $25,567 at the mines, the output of no mine exceeding $10,000 in value. The percentage of copper in the ore varied from 6 to 29 per cent. The share received by the mine owner ranged from 10 to 20 per cent of the gross value of the ore, and from 10 to 25 per cent of the value at the mine, after smelting and freight charges were deducted. The miner, out of his share of the product, furnished his own supplies.

Days in operation.—In the following table 126 copper mines are classified by the number of days in operation; 18 of the 144 mines failed to report on this subject:

TABLE 11.—*Number of mines, classified according to time in operation, by states and territories: 1902.*

STATE OR TERRITORY.	Number of mines reporting.	NUMBER OF DAYS IN OPERATION.											
		30 and less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 360.
Total	126	3	2	6	3	7	8	9	3	4	9	33	39
Arizona	31	2	....	1	....	3	4	1	2	2	....	2	14
California	7	....	....	....	1	....	....	1	....	....	1	1	3
Colorado	16	....	....	1	2	3	3	2	....	....	2	3	....
Idaho	1	....	....	....	....	....	....	....	....	....	....	....	1
Michigan	20	....	....	....	....	....	....	....	....	....	....	20	....
Montana	27	....	1	....	....	1	1	3	....	2	2	....	17
New Mexico	7	1	....	1	....	....	....	....	1	....	1	2	1
North Carolina	2	....	....	....	....	....	....	....	....	....	2	....	....
Oregon	1	....	....	1	....	....	....	....	....	....	....	....	....
Tennessee	2	....	....	....	....	....	....	1	....	....	....	1	....
Utah	9	....	....	2	....	....	....	1	....	....	....	4	2
Virginia	1	....	....	....	....	....	....	....	....	....	1	....	....
Washington	1	....	....	....	....	....	....	....	....	....	....	....	1
Wisconsin	1	....	1	....	....	....	....	....	....	....	....	....	....

Miscellaneous expenses.—This item includes rent and royalties of all descriptions, "taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere." The total amount reported under this head was $1,397,465. Of this amount $130,215 was paid in rent and royalties, viz, $33,184 in royalties for mine and mineral land, $22,393 in water rents, and $74,638 in other rents and royalties. On the whole, royalties and rents were but an insignificant item in the copper mining industry. All other miscellaneous expenses aggregated $1,267,250.

Supplies and materials.—The general term "materials" has scarcely any application to copper mining. The "material" operated upon in a mine is the rock underground. The inquiry calling for "total cost of supplies and materials of all kinds used during the year" at the mine contained the following explanatory note:

"The cost of the following materials should be reported under this inquiry: Lumber and timber used for repairs, mine supports, track ties, cars, and all other purposes; iron and steel for blacksmithing, rails, frogs, sleepers, etc., for tracks and repairs, parts of machinery and tools used for renewals and repairs; explosives, water for boilers and for other purposes, fuel, illuminating and lubricating oils, machinery supplies, etc."

All the items here enumerated strictly come under the definition of "supplies." The "material" treated at the mills is the ore which comes from the mine. It is not customary in mining bookkeeping to charge the mill with the value of the ore brought from the mine. In the schedule relating to "reduction works, other than smelters," there were two separate inquiries, one relating to "materials," the other to "supplies." The former called for a statement of the "character of materials used, whether ore, tailings, or other materials," and was confined to "materials bought in 1902." The amount reported in answer to this inquiry is not included in the "cost of supplies and materials" shown in Table 1, but is given as a separate item. Purchased ores formed but a very insignificant part of the total tonnage treated at mills connected with copper mines, namely, 1,068 tons out of a total of 6,558,222 tons treated in 1902.

The explanatory note to the inquiry relating to mill "supplies" enumerated: "Shoes, dies, screens, plates, and other parts of machinery and tools used for renewals and repairs; quicksilver, cyanide of potassium, lumber, iron, steel, oil, fuel, water, etc." The total cost of "supplies and materials," as herein defined, was reported as $11,083,175.

Mechanical power.—The total primary power of all classes used in copper mines aggregated 198,507 horsepower, of which more than two-thirds, viz, 137,772 horsepower, was used in Michigan, and one-fourth, viz, 49,090 horsepower, in Montana. The quantity of power used had no relation to either the value of the product or the copper contents of the ore, but was roughly proportionate to the quantity of crude ore mined, as appears from the following statement:

Horsepower used and tons mined, by states and territories: 1902.

STATE OR TERRITORY.	Total horsepower.	Tons mined.	Horsepower per cent.	Tons mined, per cent.
United States	198,507	11,780,064	100.0	100.0
Michigan	137,772	6,247,317	69.4	53.0
Montana	49,090	3,428,860	24.7	29.1
All other states and territories	11,645	2,103,887	5.9	17.9

The predominating form of power used in 1902 was steam. The total horsepower used, including all primary power owned and electric power rented, was divided as follows: Steam, 189,426, or 95.4 per cent; compressed air (described in the tables as "other power"), 5,235, or 2.6 per cent; gas or gasoline, 1,184, or six-tenths of 1 per cent; water, 326, or two-tenths of 1 per cent; and rented power, all electric, 2,336, or 1.2 per cent. In addition there were 50 electric motors, having a capacity of 2,312 horsepower.

The average horsepower per mine was 1,379. The power supplied by all mines to other establishments was only 87 horsepower. Twelve mines in Silverbow county, Mont., 1 mine in Salt Lake county, Utah, and 1 in Shasta county, Cal., were supplied with power by other establishments. The arrangement was apparently made feasible by the proximity of mining centers like Butte or Salt Lake City. The mine in Shasta county was supplied by a San Francisco power company from one of its substations located in the mountains.

The total number of steam engines was 792, or an average of 5.5 per mine, with an average capacity of 239 horsepower per engine. The total number of gas or gasoline engines was 35, with an average capacity of 34 horsepower per engine. They were reported from 13 mines, of which 1 used also steampower and 1 waterpower. The total number of electric motors was 50, with an average capacity of 46 horsepower per motor. Electric power was reported from 18 mines, nearly all very large producers, namely, 5 with an output exceeding $1,000,000; 8 with an output ranging from $500,000 to $1,000,000; 1 with a product above $250,000, but less than $500,000; 1 with a product above $100,000, but less than $250,000; 1 with a product above $50,000, but less than $100,000; and 2 with a product less than $10,000, of which 1, however, expended during the year more than $250,000 in development work. Compressed air was reported from 16 mines, of which 8 were located in Montana. Waterpower was reported from 6 mines, of which 2 used also steampower and 1 a gas engine. There were in all 8 water wheels in use, with an average capacity of 41 horsepower per wheel.

The exclusive use of gas or water power is characteristic of mining on a small scale. Of the 41 mines coming under the description of small mines there was none with an output exceeding $50,000, while for 7 the value of the product was between $10,000 and $50,000, and for 15 it was between $1,000 and $10,000. At 2 mines a little over $10,000 each was expended, in 1902, in development work with but small returns.

The use of steampower in copper mines in 1870, 1880, and 1902 is shown in the following statement. No information for 1889 is available.

Steampower used: 1902, 1880, and 1870.

YEAR.	Total number of mines.	NUMBER OF ENGINES.		HORSEPOWER.		
		Total.	Average per mine.	Total.	Average per engine.	Average per mine.
1902	144	792	5.5	189,426	239	1,315
1880	41	135	3.3	13,511	100	330
1870	[1] 40	93	2.3	6,328	68	158

[1] Establishments.

Within the past twenty-two years the average number of steam engines, the total horsepower used, and the average horsepower per engine have grown in a remarkable degree. On the other hand, the use of waterpower had practically been discarded in copper mines as early as 1870. The total number of water wheels reported at the Ninth Census was 3 with a total of 70 horsepower, as compared with 93 steam engines with 6,328 horsepower.

The following table shows the number of hoists, pumps, and power drills, with the kind of power used to run the same, for Western and Southern states and territories in 1902. No reports on this subject were received from Michigan (which state has reported more than two-thirds of the horsepower used at mines), Nevada, Virginia, and Wisconsin.

TABLE 12.—HOISTS, PUMPS, AND POWER DRILLS, IN WESTERN AND SOUTHERN STATES AND TERRITORIES, CLASSIFIED BY KIND OF POWER USED: 1902.

STATE OR TERRITORY.	Number of mines reporting.	HOISTS, KIND OF POWER.					PUMPS, KIND OF POWER.						POWER DRILLS, KIND OF POWER.			
		Total number.	Steam.	Gas or gasoline.	Compressed air.	Electric.	Total number.	Steam.	Gas or gasoline.	Compressed air.	Water.	Electric.	Total number.	Steam.	Compressed air.	Electric.
United States	121	228	158	16	51	3	160	153	2	2	2	1	900	135	763	2
Arizona	30	42	31	10		1	17	17					25	1	22	2
California	7	9	5	1	1	2	3	2				1	29		29	
Colorado	18	10	6	2	2		2	1		1			7		7	
Idaho	1	2	2				5	5					3	3		
Montana	27	135	87	1	47		109	106	1		2		710	72	638	
New Mexico	17	9	9				10	10								
North Carolina	2						2	2					1		1	
Oregon	2	2	2				2	2								
Tennessee	2	6	6				4	4					73	56	17	
Utah	13	12	9	2	1		6	4	1	1			49	3	46	
Washington	1												3		3	
Wyoming	1	1	1													

At the mines reporting there were 228 hoists in use in 1902, an average of about two per mine. Of this number 158 were run by steam, 51 by compressed air, 16 by gas or gasoline, and 3 by electricity. The use of compressed air as a motive power for hoists was practically confined to Montana, there being only 2 engines of that class in operation in Colorado, 1 in California, and 1 in Utah. Of the 3 electric hoists, 1 was used in Arizona and 2 in California.

There were 160 pumps in operation, an average of 1 per mine; practically all were operated by steam, the exceptions being 2 each operated by gas or gasoline, compressed air, and water, and 1 by electricity.

Of the 122 mines reporting machinery, the number reporting power drills was 34. At these mines there were 900 power drills in operation, of which nearly four-fifths were reported from Montana. The motive power was mostly compressed air; only 135, less than one-sixth of the number reported, were operated by steam and only 2 by electricity. Those operated by steam were distributed as follows: Montana, 72; Tennessee, 56; and all other states, 7. In the Tennessee copper mines steam still held the first place, only 17 drills having been run by compressed air.

The following is a statement of the tonnage mined and the wages paid to miners and miners' helpers below ground in mines equipped with power drills and in those not reporting them:

Tonnage mined and wages paid to miners and miners' helpers in mines with and without power drills: 1902.

	Number of mines.	TONS MINED.		Wages of miners.	Wages of miners' helpers.
		Number.	Average per mine.		
Total [1]	122	5,440,952	44,598	$7,850,063	$582,786
With power drills	34	4,667,766	137,287	6,030,485	502,045
No power drills reported	88	773,186	8,786	1,819,578	80,741

[1] Michigan, Wisconsin, and Virginia not reported.

It appears that about six-sevenths of all ore produced in the 122 mines reporting came from mines equipped with power drills. The average tonnage per mine thus equipped was about fifteen times as great as the average for other mines. Miners' wages averaged $1.29 per ton for mines having power drills and $2.35 for those reporting none. On the other hand, wages of miners' helpers averaged 11 cents per ton for each class.

There were 32 mines which had no mechanical power; of these 26 were in the development stage, with a total product valued at $78,176, averaging $3,007 per mine; and 6 in the productive stage, with a total product of $121,420, averaging $20,237 per mine. There were, moreover, 9 mines which failed to report on mechanical power, presumably because they had none; their total product was valued at $141,373, averaging $15,708 per mine. This leaves a product of $50,837,067 for the 102 operators (exclusive of 1 holding company) reporting mechanical power, averaging $498,402 per mine. It is evident that the mines without mechanical power were either in the incipient stage or belonged to the type of small mines. These mines were distributed among the states and territories as follows: Arizona, 10; Colorado, 9; New Mexico, 8; Montana, 7; California and Utah, 2 each; Nevada, Virginia, and Wisconsin, 1 each.

In most of the copper mines some mechanical method was used for the transportation of the ore from the mine to the reduction works or the nearest point of shipment. Of the 122 operators reporting on this subject only 29 hauled their ore by teams, while 93, or three-fourths of the whole number, reported some mechanical method of transportation. The total length of railroad tracks reported was 55 miles on the surface and 145 miles underground, and the total number of locomotives in use was 28. Of the 55 miles of surface tracks, 5 companies owned 42 miles, as follows: In Tennessee, the Tennessee Copper Company, 11 miles, and the Ducktown Sulphur, Copper and Iron Company (Limited), 7 miles; in Arizona, the Arizona Copper Company (Limited), 10 miles, and the Detroit Copper Mining Company, 4 miles; and in Idaho, the White Knob Copper Company (Limited), 10 miles. This does not include railroads intended for general traffic. The remaining 13 miles of surface tracks were distributed among 117 mines. No reports on the subject of railroad ownership were received from the Lake Superior region and Virginia.

Water plants are an important part of the mine equipment. The reports showed 66 miles of ditches, flumes, etc., of which 42 were in Colorado, an average of more than 2 miles per mine; 8 in California, an average of more than 1 mile per mine; and 16 in all other states, making an average of 715 feet per mine.

Production.—The value of the output of copper mines was $51,178,036. This was the value at the mine of the product classed as copper ore, rough or dressed. The gross value of the copper contents of the same was $70,175,810; the total value of the copper contents of all ores mined in the United States was $71,192,014. The following table sets forth in detail the relation between these values:

TABLE 13.—*Copper contents of all ores mined, and production of copper mines, values less charges: 1902.*

Total value of copper contents of all ores mined				$71,192,014
Copper contents of gold and silver ores				1,016,204
Copper contents of copper ores				70,175,810
Production of copper mines:				
Contents of ores sold or treated and gross value of same—				
Copper	pounds	625,004,529	$70,175,810	
Gold	fine ounces	92,911	1,854,025	
Silver	fine ounces	11,452,280	5,833,256	
Lead	pounds	552,070	19,053	
Iron			22	
Increase in stock of ore, estimated value			77,792	
				77,959,958
Less:				
Treatment and freight charges			26,762,189	
Cost of purchased ores, 1,068 tons			19,733	
				26,781,922
Value at the mine				51,178,036

The value of the ore shown is computed in conformity with the customary method adopted in settlements between mine operators and smelters for gold and silver bearing copper ores. The mine operator is credited with the value of the copper and other metals contained in his ore, at a stipulated price per pound of copper, per ounce of gold and silver, etc., and he is charged a stipulated price per ton for treatment and for freight from the mine to the smelter. The difference paid to him is the value of the ore at the mine.

The price of copper averaged 11.2 cents per pound; the price of silver, about 50.9 cents per fine ounce; and gold was generally paid for at the rate of $19.95 cents per fine ounce. The usual allowance for the gold contents of the copper ore was at a round figure of $20 per fine ounce, the difference between this rate and the coining rate of $20.67 per ounce being reckoned among the charges for treatment.

The preceding table shows, among the metallic contents of the copper ore, iron valued at $22. An allowance for iron is made only on those ores which are sufficiently rich in that metal to be of value as a fluxing material.

The increase of the stock of ore represents a portion of the ore mined in 1902 which remained unsold on January 1, 1903. The value is necessarily an estimate. It applies only to the mines the ore from which was sold in crude state, the gross value and the charges being reported for the portion sold, the value of the rest being estimated on the same basis. Where the ore was dressed at the mine, or shipped to a smelter operated under joint management with the mine, it was impossible in most cases to estimate the value of the ore in the bins, the segregation of the cost of milling from other expenses being impracticable.

The increase in the stock of ore reported was 39,494 tons, or three-tenths of 1 per cent, out of a total of 11,780,064 tons mined. Evidently, as a rule, only the tonnage treated was reported. The 1,068 tons of ore purchased by the mills are taken to be a duplication of the product of some mines, which reported the value of their ores sold. Therefore the value of this ore, $19,733, is deducted from the total value reported for

1902. Yet it is possible that this ore may have come, in part at least, from mines idle in 1902. The error, if any, is a negligible quantity.

In the following table the bullion contents of the copper ores mined in 1902 are shown by states and territories:

TABLE 14.—BULLION CONTENTS OF COPPER ORES SOLD AND TREATED, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	COPPER		SILVER.		GOLD.		LEAD.		IRON.
	Pounds.	Value.	Fine ounces.	Value.	Fine ounces.	Value.	Pounds.	Value.	Value.
United States	625,004,529	$70,175,810	11,452,280	$5,833,256	92,911	$1,851,025	552,070	$19,653	$22
Arizona	121,235,516	13,351,837	612,744	311,556	15,526	310,071	431,360	15,527	22
California	26,539,204	3,055,817	714,785	370,737	17,211	353,274			
Colorado	644,960	64,197	19,603	9,854	715	14,362	61,770	1,929	
Michigan	171,102,065	20,100,425	24,953	12,097					
Montana	267,779,794	30,031,912	9,675,603	4,935,070	32,153	644,178			
New Mexico	7,297,383	[1] 400,318	6,048	3,021	229	4,576			
Utah	17,600,076	1,795,511	375,874	181,937	26,893	521,225	50,540	1,903	
Southern states[2]	12,661,328	1,356,950	11,567	3,510	120	2,240			
All other states[3]	152,583	17,834	11,093	5,574	64	1,099	8,400	294	

[1] The value for New Mexico is a flat value and does not include charges for smelting and freight.
[2] Includes North Carolina, Tennessee, and Virginia.
[3] Includes Idaho, Nevada, Oregon, Washington, Wisconsin, and Wyoming.

Some silver was contained in the copper ores mined in every state; but the silver contents of the Lake Superior ores were too insignificant to pay for the cost of recovering them, and, as a rule, brought no value to the owner. For the same reason no returns were made to the mine operator for the gold and silver contents of the southern ore, though some of them ultimately reached the eastern electrolytic refineries where the precious metals were saved, thus increasing the refined gold and silver product brought into the market.

The average price realized by the mine operator for the copper contents of his ore varied by states, as shown in the statement below from 5.5 cents per pound in New Mexico to 11.7 cents in Michigan. The extremely low price in New Mexico was a flat price, no charges being made for smelting and freight. The variations in other states were produced by the fluctuations of the New York price of copper in the course of the year, and depended further upon the manner in which the ore was disposed of, as will be fully explained.

Average price per pound of copper in the ore, by states and territories: 1902.

STATE OR TERRITORY.	Cents.
United States	11.2
Arizona	11.0
California	11.5
Colorado	10.0
Michigan	11.7
Montana	11.2
New Mexico[1]	5.5
Utah	10.2
Southern states[2]	10.7
All other states[3]	11.7

[1] The price for New Mexico was a flat price, from which no deduction was made for smelting and freight.
[2] Includes North Carolina, Tennessee, and Virginia.
[3] Includes Idaho, Nevada, Oregon, Washington, Wisconsin, and Wyoming.

All copper ores mined in the United States are reduced to the metallic state by smelting, some after being crushed at stamp mills and dressed, that is, cleaned of worthless rock, and thus concentrated into a smaller volume. Dressing is the universal practice in the Lake Superior district, while in western mines it is infrequent. A comparative statement of ores dressed before smelting and those shipped in crude state follows:

Method of treatment of copper ore: 1902.

	COPPER CONTENTS.			GROSS VALUE	
	Tons of ore.	Pounds.	Per cent of crude ore.	Aggregate.	Average per ton
Total	11,464,868	625,004,529	2.73	$70,175,810	$6.12
Dressed before smelting	[1] 6,559,397	223,935,242	1.68	25,987,738	3.89
Smelted in crude state	[2] 4,905,471	401,069,287	4.19	44,188,072	9.21

[1] The contents of 1,068 tons of ore sold by the mine operators and dressed by the purchasers are included under both heads, and to this extent constitute a duplication.
[2] The copper contents of 123,393 tons of ore smelted in crude state were included in one item with those of ore dressed before smelting.

The ore shipped from the mine directly to the smelter was of a higher grade than the average ore which had to be dressed before it could be shipped to the smelter, the average value per ton of crude ore being $9.24 for the former and $3.89 for the latter. Since, however, the dressed ores included Lake Superior copper bearing rock, which is of a much lower value than western crude ores, the latter are presented separately in the following statement:

Copper contents and gross value of western crude ores: 1902.

	COPPER CONTENTS.			GROSS VALUE	
	Tons of ore.	Pounds.	Per cent of crude ore.	Aggregate.	Average per ton
Total	5,144,495	441,241,136	4.29	$48,718,216	$9.47
Sold in crude state	[1] 490,248	46,612,446	4.74	4,059,618	8.26
Dressed before smelting	[1] 711,140	52,833,177	3.71	5,888,403	8.28
Smelted in crude state at works connected with mine	3,943,107	341,795,513	4.33	38,771,195	9.83

[1] Includes a duplication of the contents of 1,068 tons of ore as explained above.

Of the 711,140 tons dressed before smelting only 39,551 tons, or 5.6 per cent, were shipped to outside smelters, the rest, after concentration, was shipped for smelting to works operated by the mine owners. The practice of dressing before smelting was confined to Arizona.

As appears from the preceding statement, the grade of ore did not vary materially with the disposition of the same. The way in which the ore was handled was apparently determined by the equipment of the mining company.

In the copper industry the combination of mining and smelting under the same operator is the predominating type of organization. The total value of the ore shipped to smelting works operated in connection with mines amounted to $40,432,863, whereas the value of the ore shipped to custom smelters was only $10,745,173. The number of mines connected with smelters was 29, and the number from which ore was shipped to custom smelters was 115. The average output per mine was $1,049,409 for the former and $93,436 for the latter.

The following table shows, by states and territories, the gross value and the metallic contents, the charges for treatment and freight and the value of the product at the mine for ores sold and for those smelted by the mine operator. The Lake Superior district and the Southern states are combined to avoid disclosing items reported by individual establishments.

TABLE 15.—VALUE OF ORE SOLD AND SMELTED BY OWNER, COST OF REDUCTION, AND VALUE AT MINE, BY STATES AND TERRITORIES: 1902.

	UNITED STATES.			ARIZONA.		CALIFORNIA.	
	Total.	Sold.	Smelted.	Sold.	Smelted.	Sold.	Smelted.
Tons sold and treated	11,464,868	3,966,521	7,498,347	25,913	1,149,319	33,090	202,508
Copper contents:							
Pounds	625,004,529	125,168,829	499,835,700	3,698,128	117,437,418	4,358,489	22,171,865
Per cent of crude ore	2.7	1.58	3.32	7.14	5.11	6.59	5.47
Value	$70,175,810	$13,001,509	$57,174,301	$351,130	$13,000,707	$479,407	$2,574,410
Average value per pound, cents	11.2	10.4	11.4	9.4	11.1	10.9	11.6
Value of by-products:							
Silver	$5,833,256	$1,181,631	$4,651,625	$45,331	$266,225	$117,241	$253,496
Gold	$1,884,025	$235,673	$1,648,352	$8,291	$301,780	$92,958	$260,316
Other metals	$19,175	$19,175		$15,549			
Total gross value	$77,882,166	$14,407,888	$63,474,278	$420,301	$13,568,712	$689,606	$3,088,222
Average per ton	$6.79	$3.63	$8.45	$38.03	$11.66	$20.84	$15.25
Cost of reduction and freight	$26,762,189	$3,740,507	$23,021,682	$167,623	$5,557,544	$311,254	$1,866,911
Average per ton	$2.33	$0.95	$3.06	$15.17	$4.77	$9.41	$9.22
Value at mine	[1] $51,119,977	$10,667,381	$40,452,596	$252,678	$8,011,168	$378,352	$1,221,311

	MONTANA.		UTAH.		OTHER WESTERN STATES.[2]		LAKE SUPERIOR DISTRICT AND SOUTHERN STATES.[3]	
	Sold.	Smelted.	Sold.	Smelted.	Sold.	Smelted.	Sold.	Smelted.
Tons sold and treated	405,278	3,027,806	14,152	231,866	52,421	2,085	3,435,654	2,884,719
Copper contents:								
Pounds	31,108,927	236,670,867	2,711,026	14,869,850	8,025,950	68,966	75,296,170	108,196,934
Per cent of crude ore	3.84	3.91	9.58	3.21	7.65	1.65	1.10	1.88
Value	$2,761,056	$27,270,876	$206,078	$1,589,143	$477,071	$5,068	$8,723,797	$12,733,797
Average value per pound, cents	8.9	11.5	7.6	10.7	5.9	7.3	11.6	11.7
Value of by-products:								
Silver	$939,105	$3,998,665	$50,108	$131,729	$16,949	$1,500	$15,597	$10
Gold	$27,684	$616,774	$55,078	$469,440	$19,695	$342	$2,240	
Other metals			$1,900		$1,623			
Total gross value	$3,727,845	$31,886,315	$313,164	$2,190,312	$515,338	$6,910	$8,741,634	$12,733,807
Average per ton	$9.20	$10.53	$22.13	$9.45	$9.83	$3.31	$2.54	$4.41
Cost of reduction and freight	$1,716,847	$13,339,351	$113,580	$929,704	$192,802	$3,215	$1,238,401	$1,328,047
Average per ton	$4.24	$4.41	$8.03	$4.01	$3.68	$1.54	$0.36	$0.46
Value at mine	$2,010,998	$18,546,964	$199,584	$1,260,608	$322,536	$3,695	$7,503,233	$11,405,760

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[1] Does not include $58,670, the difference between value of increase of stock on hand at close of year, having been neither sold nor smelted, and the value of ore purchased. Included here but not shown in Table 1.

[2] Includes Colorado, Idaho, Nevada, New Mexico, Oregon, Washington, and Wyoming.

[3] Includes Michigan, North Carolina, Tennessee, Virginia, and Wisconsin.

The cost of reduction and freight includes all charges of any description deducted by the buyer of the ore from the gross value of the same, whenever the ore was sold, or all charges made by the smelting works against the mine whenever both were operated by the same owner. Most of the Michigan mines reported separately commissions, selling expenses, etc.; some reported separately the cost of haulage from mine to smelter.

When a mine was operated in connection with a smelter, a separate report was secured for the latter, except in one case, where the smelter was operated merely as a test for a few days. The inquiries called for the total amount paid in salaries and wages during the year 1902, the cost of supplies used during the year, and miscellaneous expenses, covering substantially the same items as indicated above; also total tolls received for custom smelting and refining, as well as total tolls paid on the product of the smelter shipped for further treatment to other smelters and refineries. In accordance with the general plan of the census of mines and quarries the expenses of the smelting works were not included among mining expenses. But when no charges were made on the books of the smelter against the mine, both being operated as one establishment, the total expenses reported for the smelter were regarded as the cost of smelting the ores shipped from the company's mine and were deducted from the gross value of the bullion contents, in order to arrive at the value at the mine. Thus the gross value in Table 13 represents the value of the refined product, and the value at mine is that of the ore computed as herein explained. No attempt was made to estimate the profits of the operator on the smelting of the ores mined by him, as it would be purely a matter of conjecture. It was assumed that the ore was treated at cost, and the profit, if any, is therefore included in the value of the product at the mine.

When, in addition to the ores mined, custom ores were treated by the smelter, the expenses of the smelter were apportioned between the ores mined and those purchased on the basis of the tonnage, and the amount chargeable against the mine was deducted from the gross value. The total quantity of custom ores thus treated was only 447,944 tons, as compared with 7,513,269 tons shipped from mines operated under the same management, or 5.6 per cent of the total quantity treated. Thus any error in that calculation could not materially affect the results.

The value of the product at the mine, thus computed, represents the value of the ore, crude or dressed. The value of the ore at the mine shown in Table 13 differs slightly from that shown in Table 15. The difference amounts to $58,059, which is due to the omission from Table 15 of the estimated value of the increase of stock of ore, amounting to $77,792, and the inclusion of the cost of purchased ores, amounting to $19,733.

The average tenor of copper in the crude ore was 2.7 per cent or "units" of 20 pounds to the ton, and the average value per pound of copper contents was 11.2 cents; the gross value per ton on that basis averaged $6.79. Of the ores sold, nearly seven-eighths were Lake and Southern low-grade ores; taking the United States as a whole, therefore, the average percentage of copper for ore sold appears to have been less than one-half of the average for ores smelted. A comparison by states discloses a different condition; with the exception of Montana, ores shipped to custom smelters were of a higher grade than those smelted at the mine; apparently, low-grade ore could not bear the expense of shipment to a distant smelter, and could be profitably treated only at the mine. In Montana the grade of ore does not differ in the two cases, which is due to the fact that most of the mines are centered near Butte, so that the cost of transportation is not of such importance as elsewhere. The last group, combining the Lake Superior district and the Southern states, merely reflects the defects of the United States average, the reasons for which have been explained.

The average value realized per pound of copper is 1 cent less for ore sold than for ore smelted by the owner. The same relation is observed everywhere, the difference in price on Western ores varying from seven-tenths of a cent in California to 3.1 cents in Utah. The margin represents a part of the charges for the treatment of the ore. The low price reported from "other Western states" is due to the fact, as explained above, that in New Mexico ores containing 7,297,383 pounds of copper, and valued at $400,318 were sold at a flat price, no deductions being made for treatment. In the Lake Superior district the same value is allowed per pound of fine copper in the dressed ore (locally known as "mineral") and in refined bullion. The slight variation of one-tenth of a cent is due to the difference in Southern ores.

The average charges for treatment and freight must be compared by states or groups of states, inasmuch as the result for the United States is affected by the inclusion of Lake ores which are shipped to the smelter after being considerably reduced in weight by dressing. Of the total quantity of Lake ores, 5,036,547 tons were reduced to 120,042 tons of mineral—that is, to 2.4 per cent of the original weight. This method naturally reduced the cost per ton of rock treated. Compared by states the cost of treatment varies; in California and Montana, as well as in the Lake Superior district and in the Southern states, there is no apparent difference between the charges on ores sold and those smelted by the mine operator, whereas in all other Western states the cost of treatment is higher for the former than for the latter.

A segregation of the cost of reduction into charges for treatment and freight was not in all cases obtainable. The aggregate charges for reduction amounted to $26,762,189. This amount was distributed as follows:

Cost of reduction of ores: 1902.

	All ores.	Ore sold.	Ore smelted by owner.
Total	$26,762,189	$3,740,507	$23,021,682
Charges for treatment, etc.	22,124,950	2,633,857	19,491,093
Freight	3,402,359	549,260	2,853,099
Not reported separately	1,234,880	557,390	677,490

As appears from the preceding statement, 95.4 per cent of the total cost of reduction reported for ores smelted by the mine operators, and 85 per cent of the total reported for ores sold, could be segregated into freight and other charges. Freight, as far as reported, amounted to about one-sixth of the cost of reduction for ores and concentrates shipped to outside smelters, and to about one-eighth for ores smelted at works connected with the mine. The item of freight amounted, in all, to $3,402,359, which was equal to a charge of 4.4 per cent on the gross value of the ore.

Mines and mills.—When a mine and reduction works were operated under the same management, separate reports were required for each, and special schedules were provided for the purpose. Still the mine operator was given the option of making one report covering both the mine and the reduction works, whenever it was impracticable to report them separately.

In the Lake Superior district, where ore dressing is an integral part of copper mining, the reports furnished by the mine operators included in each case both the mine and the mill. Separate reports for mine and mill were received from each of the 7 western operators. A summary of these reports is presented in the following table:

TABLE 16.—*Summary of mines combined with mills where separately reported: 1902.*

	Mines and mills.	Mines.	Mills.
Number of mines and mills	7	7	7
Salaries	$164,517	$131,404	$33,113
Wages	$1,562,646	$1,277,963	$284,683
Contract work	$44,891	$44,891	....
Miscellaneous expenses	$137,213	$76,713	$60,500
Cost of supplies and materials	$716,468	$592,887	$123,581
Cost of purchased ores	$19,733	....	$19,733
Value of product at mine	$4,237,688	....	....
Ore mined, short tons	734,555	734,555	....
Crude ore shipped to smelters, short tons	146,160	....	....
Ore milled, short tons:			
From mine	585,539	....	585,539
Purchased	1,068	....	1,068
Concentrates produced, short tons	77,903	....	77,903
Bullion contents of ore shipped and milled:			
Copper—			
Pounds	57,370,088	....	....
Gross value	$6,116,100	....	....
Silver	$45,263	....	....
Gold	$25,022	....	....
Other metals	$15,527	....	....
Total gross value	$6,201,912	....	....

The following table is a summary of all mines that were separately reported, with and without mill connection. Lake Superior mines, as stated, do not come within this category. The table is confined to mines only; no data relating to mills are included therein.

TABLE 17.—*Summary, exclusive of mills, for mines with mill connections compared with mines not connected with mills: 1902.*

	Mines reporting.	Mines with mill connection.	Mines not connected with mills.
Number of mines	123	7	116
Salaries	$1,137,267	$131,404	$1,005,863
Wages	$12,121,518	$1,277,963	$10,843,555
Contract work	$177,043	$44,891	$132,152
Miscellaneous expenses	$862,519	$76,713	$785,806
Cost of supplies and materials	$6,271,175	$592,887	$5,678,288
Value of product at mine	$32,872,560	$3,735,811	$29,136,749
Ore mined, short tons	5,542,712	734,555	4,808,157
Ore shipped and milled:			
Short tons	5,493,218	731,699	4,761,519
Bullion contents—			
Copper—			
Pounds	453,452,464	56,920,068	396,532,376
Value	$50,055,442	$6,096,367	$43,959,075
Silver	$5,821,159	$45,263	$5,775,896
Gold	$1,854,025	$25,022	$1,829,003
Other metals	$19,075	$15,527	$3,548

Where the mine was connected with a mill the value of product reported was that of the mill product, which would not be comparable with the value reported by mines without a mill connection; the value at mine has, therefore, been estimated in the same manner as in cases where the ore was smelted at works connected with the mine; the total reported expenses of the mill have been deducted from the value of the mill product, and the difference is taken to represent the value of the crude ore at the mine. The gross value of the product is obtained by deducting the cost, $19,733, of ore purchased for the mill, from the gross value of the bullion contents; the same amount being deducted from the reported value of copper, in order to obtain the value of the copper contents of the ore mined. The value of the copper contents of purchased ore, of course, exceeded the price paid by the mill for the crude ore. Yet as the copper contents of purchased ores were less than 1 per cent of the total quantity treated, they may be regarded as a negligible quantity.

Comparison by geographic divisions.—The growth of the copper production in the United States is mainly the result of the development of copper mining in Montana and Arizona. In 1879 five-sixths of the production of the United States came from Michigan; though the annual production of Michigan has since more than trebled, the relative share of Michigan had declined to a little over one-fourth in 1902, while the output of Montana and Arizona for the year 1902 amounted to nearly three-fifths of the production of the United States. The copper production of the above three states and of the United States since the year 1883 when records for Montana and Arizona began, is presented in the following table:

TABLE 18.—*Production of the United States, and of the Lake Superior, Montana, and Arizona districts: 1883 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Long tons.]

YEAR.	Total production, United States.	LAKE SUPERIOR.		MONTANA.		ARIZONA.	
		Production.	Per cent of total.	Production.	Per cent of total.	Production	Per cent of total.
1883	51,574	26,653	51.6	11,011	21.3	10,658	20.7
1884	64,708	30,961	47.8	19,256	29.8	11,935	18.4
1885	74,052	32,209	43.5	30,267	40.9	10,137	13.7
1886	70,430	36,124	51.3	25,362	36.0	6,990	9.9
1887	81,017	33,941	41.9	35,133	43.4	7,910	9.7
1888	101,054	38,604	38.2	43,704	43.2	14,195	14.0
1889	101,239	39,364	38.7	43,849	43.3	13,654	13.5
1890	115,966	45,273	38.9	50,437	43.5	15,534	13.4
1891	126,839	50,992	40.2	50,028	39.5	17,800	14.0
1892	154,018	54,999	35.7	72,860	47.3	17,160	11.1
1893	147,033	50,270	34.2	69,290	47.1	19,200	13.1
1894	158,120	51,031	32.3	81,729	51.6	19,873	12.6
1895	169,917	57,737	34.0	84,900	50.0	21,408	12.6
1896	205,384	64,073	31.2	99,071	48.2	32,560	15.8
1897	220,571	64,858	29.4	102,807	46.6	36,398	16.5
1898	235,050	66,291	28.2	92,041	39.2	49,624	21.1
1899	253,870	65,803	25.9	100,503	39.6	59,399	23.4
1900	270,588	64,938	24.0	120,865	44.7	52,920	19.5
1901	268,782	69,772	25.9	102,621	38.2	58,383	21.7
1902	294,423	76,165	25.9	128,975	43.8	53,547	18.2

A comparative summary by geographic divisions is presented in Table 19. The Lake Superior district is practically synonymous with the state of Michigan; the returns of the present census of mines and quarries show only 1 small mine in Wisconsin, with an output valued at less than $500.

TABLE 19.—*Comparative summary of western, Lake Superior, and southern copper mines: 1902.*

	Western states.	Lake Superior district.	Southern states.
Number of mines	118	25	5
Salaries	$1,106,656	$528,076	$64,321
Wages	$12,212,967	$8,745,264	$193,244
Contract work	$177,043	$11,725	....
Miscellaneous expenses	$859,031	$474,446	$65,988
Cost of supplies and materials	$6,293,251	$4,688,419	$101,505
Value of product at mine	$32,206,884	$18,247,417	$865,676
Ore mined, short tons	5,196,188	6,247,352	346,329
Ore shipped and milled:			
Short tons	5,145,563	5,971,650	348,723
Bullion contents—			
Copper—			
Pounds	441,241,136	171,102,065	12,661,328
Value, total	$48,718,216	$20,100,635	$1,356,959
Average per pound, cents	11.0	11.7	10.7
Silver	$5,817,649	$12,097	$3,510
Gold	$1,851,785	....	$2,240
Other metals	$19,075	....	....
Total gross value	$56,406,725	$20,112,732	$1,362,709
Average percentage of copper in ore	4.29	1.43	1.82
Average return from by-products:			
Per ton mined	$1.48	$0.002	$0.017
Per ton sold and treated	$1.49	$0.002	$0.016
Per pound of copper, cents	1.7	....	....

Lake Superior district.—Until the development of copper mining in the Western states, in the early eighties, the Michigan mines were practically the only source of domestic production of copper. A comparative summary of census statistics for Michigan copper mines beginning with 1860 is presented in the following table:

TABLE 20.—*Comparative summary, Michigan: 1860 to 1902.*

	1902	1889	1880	1870	1860
Number of mines	20	(1)	19	[2]27	[2]30
Salaried officials, clerks, etc.:					
Number	419	[3]41	(4)	(4)	(4)
Salaries	$528,076	$67,360	(4)	(4)	(4)
Wage-earners:					
Average number	13,687	[3]5,695	5,199	4,188	3,631
Wages	$8,744,892	$3,174,363	$2,661,243	$2,346,535	$1,388,298
Contract work	$11,725	$306,627	....	....	....
Miscellaneous expenses	$473,501	$1,247,978	(1)	(1)	(1)
Cost of supplies and materials	$4,688,419	$2,682,491	$1,215,206	$556,416	$139,500
Product:					
Pounds of copper	171,102,065	87,455,675	45,830,282	(1)	(1)
Value	$20,563,358	(1)	$7,979,232	$4,312,167	$2,171,382

[1] Not reported.
[2] Establishments.
[3] Foremen included in wage-earners.
[4] Not reported separately.

The noteworthy feature disclosed by the preceding table is the gradual concentration of production from one census to another. Assuming that the establishments reporting in 1860 and 1870 represented mines, the number of mines decreased from 1860 to 1880, and since then has remained about the same; but the output at each census has been about double the value or the quantity reported at the preceding census. The average production per mine was as follows: In 1860, $72,379; in 1870, $159,710; in 1880, $419,960; and in 1902, $1,028,168.

The progress in the equipment of mines went on in proportion to the increase in the volume of production. This is illustrated by the growth of the number and horsepower of steam engines used, as summarized in the following statement:

Steam engines and horsepower in Michigan: 1902, 1880, and 1870.

YEAR.	Number of mines.	NUMBER OF ENGINES		HORSEPOWER		
		Total.	Average per mine.	Total.	Average per engine.	Average per mine.
1902	20	439	22.0	137,322	313	6,866
1880	19	113	5.9	12,715	112	669
1870	[1]27	86	3.2	5,946	69	220

[1] Establishments.

The preceding statement clearly shows the remarkable growth of the application of steampower, especially within the last two decades. The average power employed in the production of 1 short ton of fine copper in 1880 was equal to fifty-five hundredths of 1 horsepower, and in 1902 to 1.61 horsepower, nearly threefold.

Of the 20 mines reporting in 1902, 13 made complete reports, stating the quantity of rock treated, the quantity of mineral produced, and the fine copper contents of the mineral; 3 failed to state the quantity of rock treated, but reported the quantity of mineral and copper contents; 4 reported the quantity of rock treated and the fine copper contents, but failed to report the quantity of mineral produced. The total reported quantity of rock hoisted was 6,247,317 tons, of which 5,971,615 tons were treated and 275,702 tons, or 4.4 per cent, were rejected as too poor to go to the stamp mill.

Complete reports from 13 mines showed 5,036,547 tons treated at stamp mills, with a yield of 240,084,170 pounds of mineral, containing 144,217,300 pounds of fine copper. The rock was reduced by treatment to 2.4 per cent of its weight; the fine copper contents averaged 60.1 per cent of the mineral, or 1.4 per cent of the weight of the rock. Returns from 16 mines showed 5,971,615 tons of rock treated, containing 165,631,605 pounds of fine copper, or 1.4 per cent of the quantity of ore treated. Returns from 17 mines showed 249,569,244 pounds of mineral, yielding 149,262,636 pounds of fine copper, or 59.8 per cent.

The percentage of mineral produced varied in individual cases from six-tenths of 1 per cent to 2.4 per cent of the rock treated, and the copper contents varied from 53.4 per cent to 91 per cent of the mineral. The proportion of 2.4 per cent of mineral to the quantity of rock treated and 60 per cent for the fine copper contents of the mineral, or 1.4 per cent for the fine copper contents of the rock, may be taken as representing the general average. Upon this basis the quantity of rock treated in cases where mineral alone was reported may be estimated at 198,000 tons, which would raise the quantity reported to about 6,179,000 tons, or 3.2 per cent.

The total quantity of rock hoisted in 1889 was 2,363,733 tons, of which 2,137,653 tons were treated, a part of the ore being rejected as too poor to go to the stamp mill. This quantity of ore yielded 117,804,926 pounds of mineral, or an average of 2.8 per cent. The average percentage of fine copper in the mineral was 74.2 per cent.

The progress of copper mining in the Lake Superior district is shown in the following statement:

Production and dividends of Lake copper mines, by quadrennial periods: 1879 to 1902.[1]

PERIOD.	Quantity of fine copper (pounds).	GROSS VALUE.		DIVIDENDS.		Average gross value per pound, less dividends per pound (cents).
		Total.	Average per pound (cents).	Amount.	Average per pound (cents).	
1879-1882	204,094,755	$37,709,141	18.5	$10,413,620	5.1	13.4
1883-1886	292,121,955	35,683,292	12.6	7,867,500	2.8	9.8
1887-1890	352,096,633	50,755,245	14.4	10,715,000	3.0	11.4
1891-1894	461,336,117	49,963,618	10.8	12,700,000	2.7	8.1
1895-1898	562,056,573	63,996,758	11.4	19,553,250	3.5	7.9
1899-1902	615,920,822	95,929,592	15.6	33,066,550	5.4	10.2
1899-1901	444,818,757	75,829,167	17.0	29,626,550	6.7	10.3
1902	171,102,065	20,100,425	11.7	3,440,000	2.0	9.7

[1] Compiled from the Copper Handbook, Vol. III, page 573.

In the statement which follows all Lake Superior copper companies are divided into three classes: (1) Those whose total dividends since organization have more than equalled the amount of capital stock issued, (2) those whose dividends have not equalled the amount of capital stock issued, and (3) those which have never paid any dividends.

Capital stock issued and total dividends paid since organization by Lake Superior mining companies.[1]

	Number of companies.	Stock issued.	Dividends paid.
Total	60	$46,038,500	$117,685,920
Dividends in excess of stock issued	10	5,122,000	116,045,920
Dividends short of stock issued	6	3,987,500	1,640,000
No dividends paid	44	36,929,000	

[1] The Copper Handbook, Vol. III, page 882.

The large majority of the Lake Superior copper mining companies have never paid any dividends. Of the 16 dividend paying companies 4 were absorbed by other companies, 2 of which were themselves dividend paying; 2 were closed after a successful career; 1 was closed after earning in eleven years enough to retire its outstanding capital stock; and 1 was closed after proving a losing venture. This leaves 10 active dividend paying companies, of which, however, only 3 paid dividends in 1902. The total number of active companies reported to the census of 1902 was 20; it is therefore apparent that 10 of this number had never paid any dividends. Of the 44 companies which at one time or another have operated in the Lake Superior region 34 were inactive or did not exist during the census year. The 2 mines mentioned above which closed after proving profitable investments were Cliff, which from 1849 to 1867 netted in dividends $2,407,620, after earning an amount equal to its capital stock of $111,000, and Central, which from 1864 to 1891 netted in dividends $1,870,000, after earning an amount equal to its capital stock of $100,000.

A very instructive record of mining for a long series of years is presented in the published reports of the Quincy Mining Company. It was organized in 1848 and reincorporated in 1878 with a capital stock of $2,500,000, and had paid in dividends since organization to the close of 1902, $13,920,000. The company operated its own smelter in connection with its mine, and marketed refined copper. The statistics are given in the following statement:[1]

Quincy Mining Company: 1866 to 1902.

YEAR.	Product (pounds).	Yield of fine copper per fathom broken (pounds).	Price obtained per pound (cents).	Cost per pound exclusive of construction (cents).	Number of miners.	Average monthly contract wages.
1866	2,114,220	151	31.3	29.0	227	$55.16
1867	1,921,630	526	22.7	18.9	167	50.83
1868	1,417,941	447	25.2	23.1	157	50.44
1869	2,417,365	446	21.9	16.7	210	51.10
1870	2,496,771	528	21.5	15.3	181	46.09
1871	2,409,501	441	22.8	15.2	164	47.08
1872	2,299,104	391	32.5	22.9	235	60.62
1873	2,621,087	491	26.5	18.6	223	62.42
1874	3,050,154	577	21.9	15.1	234	43.38
1875	2,798,291	495	22.7	15.8	217	46.74
1876	3,073,171	507	20.0	15.7	227	47.13
1877	2,937,014	467	18.6	15.1	247	43.79
1878	2,991,060	395	14.9	14.0	234	41.50
1879	2,639,958	463	16.3	13.7	212	38.76
1880	3,609,250	563	18.5	11.8	192	49.10
1881	5,702,606	766	18.7	10.6	212	48.51
1882	5,692,663	900	17.1	9.5	152	48.83
1883	6,012,239	850	13.7	8.9	165	46.02
1884	5,690,087	722	12.2	8.6	157	43.35
1885	5,848,497	710	11.4	7.5	132	44.00
1886	5,888,517	638	11.1	6.8	140	45.90
1887	5,603,691	791	11.7	8.6	142	48.40
1888	6,367,809	690	15.9	10.1	158	49.60
1889	6,405,686	690	12.0	9.4	145	49.15
1890	8,064,253	769	15.7	8.2	146	52.60
1891	10,542,519	695	12.8	9.1	182	53.40
1892	11,103,925	572	11.2	8.8	208	53.75
1893	11,398,477	574	10.4	7.1	259	49.60
1894	15,484,014	584	9.5	5.7	285	50.70
1895	16,394,721	517	10.1	5.9	336	50.00
1896	16,863,477	477	10.0	6.5	379	52.00
1897	16,924,618	481	11.1	6.8	393	52.52
1898	16,354,061	513	12.0	6.8	381	52.50
1899	14,301,182	427	17.0	8.1	401	56.72
1900	14,116,551	391	16.6	9.3	433	62.00
1901	20,540,720	402	16.1	8.8	531	62.00
1902	18,988,491	347	12.0	9.0	562	62.00

The preceding statement shows that the average annual production of the company increased after 1866 nearly tenfold, whereas the average number of miners employed increased about 2½ times—that is, the average miner is able to produce with modern methods and machinery about four times as much as in 1866. The cost of production per pound has been reduced to less than one-third of what it was in 1866.

Montana, Arizona, and New Mexico.—Copper mining in Montana, Arizona, and New Mexico did not develop until the eighties. Very scant information on copper mines in that region is recorded in the reports of the Tenth Census. Arizona reported 110 wage-earners whose wages aggregated $77,128. The production did not exceed 7,650 tons of ore, which contained 3,183,750 pounds of copper.

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[1] For 1866 to 1901, taken from the Copper Handbook, Vol. III, pages 458 and 459; for 1902, from the report of the company.

Montana reported in 1880 only 523 tons of ore containing 1,212,500 pounds of copper, and New Mexico had only 13 tons to show, which yielded 4,055 pounds of copper.

A comparative summary for the years 1902 and 1889 follows:

TABLE 21.—COMPARATIVE SUMMARY FOR ARIZONA, MONTANA, AND NEW MEXICO: 1902 AND 1889.

	Year.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.		
		Number.	Salaries.	Average number.	Wages.				Tons of ore.	Copper contents.	
										Pounds.	Per cent ratio per ton.
Arizona	1902	258	$389,275	3,767	$3,497,328	$152,337	$256,753	$2,135,676	1,210,301	121,235,546	5.01
	1889	14	23,762	858	726,121	23,774	48,242	325,020	155,586	31,362,685	10.08
Montana	1902	310	194,415	6,588	7,339,773	40,975	456,108	3,649,127	3,128,860	267,779,794	4.90
	1889	10	22,515	1,918	2,010,940	2,752	138,288	1,029,980	698,837	97,868,064	7.00
New Mexico	1902	24	32,120	164	128,483	10,266	26,858	19,108	46,993	7,297,383	7.76
	1889	5	7,250	240	184,701	1,320	8,338	20,169	34,586	3,883,014	5.61

The average copper contents per ton of ore mined in Montana and Arizona has considerably decreased since 1889. It may be inferred from these figures that the development of those parts of the country, and the introduction of improved processes, have made it possible to treat lower grades of ore, which could not have been profitably worked in 1889.

Smelters connected with mines.—The following table is a summary for smelters connected with mines; the expenses shown therein (salaries and wages, miscellaneous expenses, supplies and materials) are not included in the statistics of copper mines, having been used merely in estimating the value of the ore at the mine as explained on a previous page, under the head of "production."

TABLE 22.—SUMMARY OF SMELTERS AND REFINERIES CONNECTED WITH MINES: 1902.

CHARACTER OF SMELTING WORKS.	Number of establishments.	Salaries and wages.	Miscellaneous expenses.	Supplies and materials, not including ores.	Cost of refining.	Freight on bullion shipped.	MATERIALS TREATED.		Purchased matte (short tons).	Copper produced (pounds).
							Ore from mine (short tons).	Purchased ore (short tons).		
Total	29	$8,796,932	$2,156,205	$9,033,227	$1,861,001	$1,536,788	4,161,772	411,029	36,915	557,111,390
Treating ore from mine only	16	2,322,779	321,351	2,466,770	854,316	984,819	858,255	....	....	166,483,274
Treating ore mined by company and purchased ore	7	1,715,338	98,858	1,732,249	981,016	541,675	811,677	162,208	17,248	112,245,520
Connected with refinery	6	4,758,815	1,735,996	4,834,208	25,669	10,294	2,491,840	248,821	19,667	278,382,596

The summary is not intended as a complete presentation of the business transacted by the smelters, which is beyond the scope of the census of mines and quarries. The cost of purchased ores is therefore not included in the statement, nor are the earnings from the treatment of custom ores given therein. Copper smelters located in Michigan are not comprised in this statement. It includes, however, the Buffalo smelter of the Calumet and Hecla Mining Company, to which a portion of its product is shipped for treatment.

The copper product shown contains a duplication of 11,508,230 pounds, representing the contents of matte produced by one of the smelters and further treated at two of the six smelters and refineries included in the summary. The total copper product of these smelters was accordingly 545,603,160 pounds.

Copper contents of all ores mined, including gold and silver ores.—The production discussed in the preceding pages is that which is credited to the copper mines, as therein defined. For certain comparative purposes it is necessary to show the copper contents of all ores mined, including those whose chief value is that of their precious metal contents. The following statement shows the copper contents of all ores mined in 1902, by sources of production:

Copper contents of all ores mined, by sources of production: 1902.

SOURCE OF PRODUCTION.	Pounds.	Gross value at mine.
Total	636,033,392	$71,192,014
Copper mines	625,004,529	70,175,810
Gold and silver mines	11,028,863	1,016,204

The share contributed by each state or territory to the copper production of the United States is shown in the following table:

TABLE 23.—*Copper contents of all ores mined, by states and territories: 1902.*

STATE OR TERRITORY	Pounds	Value.
United States	639,033,392	$71,192,014
Arizona	121,409,275	13,367,135
California	26,549,063	3,050,908
Colorado	5,841,074	650,355
Georgia	9,500	1,235
Idaho	86,442	9,149
Michigan	171,102,065	20,100,425
Montana	268,440,090	30,092,781
Nevada	29,114	3,134
New Mexico	8,017,902	462,053
North Carolina	118,801	45,531
Oregon	46,154	2,800
South Dakota	787	67
Tennessee	12,281,515	1,316,991
Utah	24,720,824	2,272,622
Virginia	3,246	398
Washington	72,540	10,890
Wisconsin		210
Wyoming	2,000	260

Consumption of copper ores.—In order to verify the accuracy of the returns for the production of copper mines, they must be compared with the reports of all copper smelters showing the consumption of copper ores as materials for smelting.

With that purpose in view the special schedule relating to copper mines contained an inquiry calling for the name and address of the mill or works at which the ore was treated. The special schedule provided for mills ("reduction works other than smelters") called for the "name, location, and character of establishment to which the product was sold or shipped for final treatment." A similar inquiry was inserted in the special schedules addressed to smelters. These inquiries were intended to trace the product from the producer to the consumer, as well as to guard against duplications in cases where the same product was successively treated by different establishments.

Only 4 mines failed to answer the inquiry. The total production of those mines was 257 tons of ore, containing 20,604 pounds of copper, having a gross value of $2,212; in a total production of copper the gross value of which exceeded $70,000,000, this is a negligible quantity.

Copper ore mined in the United States is eventually converted into metallic copper in this country, with the exception of a small quantity exported in the shape of matte. Matte (called also "regulus") is a semimetallic product obtained from ore by fusion; it contains from 25 to 70 per cent of copper and is blown by further fusion to metallic copper.

A portion of the ore was thus concentrated at local matte smelters and shipped for further treatment to other smelters which produce pig copper. The total fine copper contents of matte shipped, according to reports received at the Bureau of the Census, amounted to 43,339,268 pounds. Of this quantity, 6,717,594 pounds were shipped to New York brokers for export; 13,325,690 pounds were traced from the matte smelters to the plants where the matte was converted into metallic copper; 22,977,984 pounds were reported by copper smelters as the contents of purchased matte, the producers of the matte failing to report; and 319,000 pounds were reported by shippers, the destination of the matte not being stated.

The copper contents of the matte, with the exception of the 13,325,690 pounds which were reported by both shippers and buyers, must be included in the total output of copper. The 319,000 pounds reported only by shippers were either intended for export, or they may have been duplicated in the report of some other smelter. Compared with the total production of the United States, the error would amount to only five-hundredths of 1 per cent.

The production of matte and metallic copper, as reported by smelters, is shown in the statement below.

The Lake Superior ores were smelted at the following works: The output of the Calumet and Hecla Mining Company and the Quincy Mining Company at their own smelters, from which reports were secured; the mineral from all other mines was treated by the Quincy Mining Company and by the Lake Superior Smelting Company, at Hancock, Mich. No report was secured from the latter. The copper product of Lake Superior ores has, therefore, been taken from the reports of the Michigan mining companies, including the two above named, which had their own smelters.

Some copper was produced by lead smelters engaged principally in the treatment of gold and silver bearing ores; the quantity reported by them is shown separately in the following statement:

Production of metallic copper and matte in the United States: 1902.

	Fine copper (pounds).
Metallic copper:	
From—	
Western and southern ores	424,721,738
Lake Superior ores	171,102,065
Imported ores	40,797,847
Reported by lead smelters	18,931,168
Matte	43,339,268
	698,892,068
Deduct duplication in matte	13,325,690
Total output of smelters	685,566,396
Less product of imported ores	40,797,847
Total copper product of all domestic ores	644,768,549
Reported by mine operators	[1]639,033,392
Variance	5,735,157

[1] Includes 14,028,983 pounds reported as by product of gold and silver ores.

The variance between the output of mines and smelters is less than 1 per cent.

The United States Geological Survey reports the total output of copper refineries as 699,508,644 pounds, and estimates the copper contents of imported ores at 40,000,000 pounds; the difference, 659,508,644 pounds, is taken to represent the copper production of the United States for 1902. This estimate exceeds the production of mines by 20,475,252 pounds, or 2.9 per cent, and the output of smelters by 15,340,155 pounds, or 2.4 per cent.

There naturally would be a difference between the copper contents of ore shipped from the mines and the quantity of copper produced by smelters and refineries. Where the ore was smelted by the mine operator the quantity reported, as a rule, represented the actual recovery of fine copper; but where the ore was shipped to a custom smelter the quantity reported represented the assay contents which were paid for. Furthermore, the periods covered by the returns were not in all cases the same, some companies reporting for their various fiscal years nearest to the calendar year 1902. Then, too, the stocks on hand and in process carried at the smelters and refineries fluctuate from one year to another. In one case reported to this office the deliveries of an electrolytic copper refinery for 1902 differed from the receipts for the same year by more than 40,000,000 pounds of fine copper. Again, duplications can not always be avoided. That the variance between the quantities reported for the several stages of the copper industry is confined within such narrow limits vouches for the substantial accuracy of the results.

Mineral lands.—The primary distinction between mining and manufacturing is that in the former industry there are three factors of production, viz, land, capital, and labor, while only labor and capital are essential in the latter. The present census of mines and quarries is the first in which the scope of the inquiry has in some branches been extended to the ownership of mineral lands. Though the special schedule provided for gold, silver, lead, and copper mines was confined to mineral lands, it is probable that in some cases the reports included all lands of any description, such as timber lands, building lots, etc.

The following table shows the distribution of mineral lands, by title of tenure, for the United States and by states and territories. For 5 of the 144 mines no report was made on this subject—3 in Arizona, 1 in New Mexico, and 1 in Virginia; 1 establishment was a holding company.

TABLE 24.—*Summary of mineral lands, by states and territories: 1902.*

STATE OR TERRITORY.	Total acres.	LAND OWNED.		LAND LEASED.	
		Number of mines.	Acres.	Number of mines.	Acres.
United States	86,523	[1]122	83,270	[1]20	3,253
Arizona	13,754	27	13,754		
California	6,120	6	5,960	1	160
Colorado	1,664	14	1,422	4	242
Idaho	544	1	544		
Michigan	39,281	20	39,281		
Montana	2,572	23	2,306	4	266
Nevada	200	1	200		
New Mexico	4,478	10	3,895	6	583
North Carolina	2,357	2	1,257	1	1,100
Oregon	1,400	2	1,400		
Tennessee	11,600	2	10,750	1	850
Utah	1,088	11	1,056	2	32
Washington	800	1	800		
Wisconsin	320	1	320		
Wyoming	345	1	325	1	20

[1] Of this number 4 mines reported both owned and leased land.

Of the acreage owned, as shown in the preceding table, 91 acres were reported by the owners as leased to other parties, viz, 16 acres in Montrose county, Colo., on which copper was not mined, and 75 acres distributed among other states and territories, upon which miners were virtually employed on a share of the product, as explained on a previous page. In the above table, consequently, these 91 acres are not duplicated.

The leasing of land apparently plays a very subordinate part in copper mining. The royalties on the 3,253 acres leased aggregated $33,184, or a little over $10 per acre. The greater part of the acreage, namely, 2,080 acres, was held by 4 operators, who, in addition to leased land, operated their own mines and made in each case only one report for the entire operation. A summary for those mines which were operated exclusively on leased land is presented in the following table:

TABLE 25.—*Number of mines operating exclusively on leased lands, acres leased, value of product, and royalties paid: 1902.*

STATE OR TERRITORY.	Number of mines.	Acreage leased.	Value of product at mine.	Royalties paid.
United States	16	1,173	$85,103	$21,291
Colorado	4	242	1,620	360
Montana	4	266	29,955	7,579
New Mexico	5	473	49,014	11,508
All others[1]	8	192	4,514	1,844

[1] Includes California, 1; Utah, 2.

The mines operated on leased land were all very small producers; a little over one-half of that land, viz, 652 acres, was still under development. The royalties paid amounted to about one-fourth of the value of the product at the mine.

In the following table all mines are classified by the area of mineral lands owned and leased:

TABLE 26.—ACREAGE OF MINERAL LANDS, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	TOTAL.		20 ACRES OR LESS.		21 TO 99 ACRES.		100 TO 999 ACRES.		1,000 TO 4,999 ACRES.		5,000 ACRES AND OVER.	
	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.
United States	139	86,523	28	340	26	1,307	59	17,345	23	48,861	3	18,670
Arizona	27	13,754			3	200	21	4,821	3	8,733	...	...
California	7	6,120	1	20	1	60	4	1,040	...	...	1	5,000
Colorado	18	1,664	4	40	8	435	6	1,189	...	...		
Idaho	1	544	...	...	...	...	1	544	...	...		
Michigan	20	39,281	...	...	...	...	4	2,740	15	31,541	1	5,000
Montana	27	2,572	17	168	5	191	5	2,213	...	...	...	...
Nevada	1	200	...	...	...	...	1	200	...	...	...	...
New Mexico	16	4,478	3	60	3	153	9	2,265	1	2,000	...	...
North Carolina	2	2,357	...	...	...	...			2	2,357	...	...
Oregon	2	1,400	...	...	...	...	1	100	1	1,300	...	...
Tennessee	2	11,600	...	...	...	...			1	2,930	1	8,670
Utah	13	1,088	3	52	6	268	4	768	...	...	...	...
Washington	1	800	...	...	...	...	1	800	...	...	...	...
Wisconsin	1	320	...	...	...	...	1	320	...	...	...	...
Wyoming	1	345	...	...	...	...	1	345	...	...	...	...

The correlation between ownership of land and value of production is shown in the following table:

TABLE 27.—*Acreage owned and leased, and value of product: 1902.*

SIZE OF HOLDING.	Number of mines.	AREA.		VALUE OF PRODUCT AT MINE.		AVERAGE VALUE.	
		Acres.	Per cent.	Amount.	Per cent.	Per mine.[1]	Per acre.[2]
Total	144	86,523	100.0	$51,178,066	100.0	$357,888	$586
Less than 100 acres	54	1,647	1.9	5,929,937	11.6	109,758	3,600
100 to 999 acres	59	17,345	20.0	20,923,808	40.9	355,319	1,206
1,000 to 4,999 acres	23	48,861	56.5	23,622,384	46.2	1,027,060	483
5,000 acres and over	3	18,670	21.6	164,951	0.3	54,984	9
Acreage not reported	[3] 5	...	...	499,958	1.0	124,989	...

[1] This average is computed only for mines reporting product.

[2] This average is computed only for mines reporting acreage.

[3] Includes one holding company.

It appears that the value of the production of the mines bore no close relation to the area of mineral lands owned or leased. Still the average value of production per mine increased with the increase in the area of mineral lands owned up to 5,000 acres, though not in the same ratio.

The average value of production per acre decreased as the area increased and the three largest owners were among the smallest producers. It is probable that while the smaller properties were under active operation the larger were awaiting development.

Concentration of the industry.—Copper mining is a highly centralized industry, as appears from the following tables. Table 28 shows the acreage of all mineral lands by districts.

TABLE 28.—ACREAGE OF MINERAL LANDS, BY DISTRICTS: 1902.

	TOTAL.		20 ACRES OR LESS.		21 TO 99 ACRES.		100 TO 999 ACRES.		1,000 TO 4,999 ACRES.		5,000 ACRES AND OVER.	
	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.	Number reporting.	Acreage.
United States	139	86,524	28	340	26	1,307	59	17,345	23	48,861	3	18,670
Western states	114	32,965	28	340	26	1,307	54	14,285	5	12,033	1	5,000
Lake Superior district	21	39,601	...	...	...	...	5	3,060	15	31,541	1	5,000
Southern states	4	13,957	...	...	...	...	...	...	3	5,287	1	8,670

The preceding table clearly illustrates the degree of concentration in the ownership of mineral lands; 78 per cent of the entire area was held by 26 companies, of which 16 were in the Lake Superior district. In the Southern states there were no mining properties of less than 1,000 acres; in the Lake Superior district only 5 held less than 1,000, the average for these being 612 acres. All small mines were located in the Western states, where the concentration was less pronounced.

Table 29 shows the classification of all copper mines of the United States by value of production.

TABLE 29.—*Classification of copper mines by value of production: 1902.*

GROUP BY VALUE.	Number in each group.	VALUE OF PRODUCT AT MINE.	
		Amount.	Per cent.
Total	114	$51,178,066	100.00
Less than $500	21	4,015	0.01
$500 to $999	9	6,523	0.01
$1,000 to $9,999	14	155,552	0.30
$10,000 to $49,999	25	578,766	1.13
$50,000 to $99,999	6	379,162	0.74
$100,000 to $249,999	8	1,160,687	2.27
$250,000 to $499,999	8	3,265,037	6.38
$500,000 to $999,999	11	8,171,374	15.97
$1,000,000 and over	12	37,456,920	73.19

As seen from the preceding table, about three-fourths of the output was contributed by 12 mines producing over $1,000,000 each, and only about one-ninth by 121 mines producing less than $500,000 each.

A similar classification by geographic divisions is impossible without disclosing the individual returns of some mine. It may be stated, however, from an examination of the statistics of production arranged by states, in the same manner as above, that the same proportions shown in the table obtain, with but slight variations, in Montana, Arizona, and the Lake Superior district, which furnish together 92 per cent of the production of the United States. The mines located in other states ranged, according to their output, as follows: 1 over $1,000,000; 1 over $500,000, but less than $1,000,000; 2 over $250,000, but less than $500,000. The output of these 4 mines was valued at $2,928,958, or 71.6 per cent of the total product of these states. There were, moreover, 62 mines distributed as follows: 6 producing over $100,000, but less than $250,000 each, with an aggregate output of $819,661, or 20.1 per cent of the total; 11 producing more than $10,000, but less than $100,000 each, with an output of $269,839, or 6.6 per cent; and 45 producing less than $10,000 each, with an aggregate output of $69,584, or 1.7 per cent.

The preceding statistics, dealing as they do with individual mines or operating companies as units, do not fully express the actual degree of concentration which manifested itself in a variety of forms. One holding company, the Amalgamated Copper Company, controlled, through the ownership of stock, 6 copper mining companies in Montana. The combined production of these companies for the year ending June 1, 1903, according to their sworn statements filed with the assessors of Silverbow county, Mont., aggregated 3,140,380 tons of ore, having a gross value of $33,635,176. Compared with the total production of the copper mines of the United States, as reported at the census of 1902, or for the fiscal year nearest to the same, the output of the Amalgamated Copper Company constituted 27.4 per cent of the tonnage and 43.1 per cent of the gross value.

Closely allied with the Amalgamated Copper Company was the Tennessee Copper Company, whose directorate included two of the directors of the former. Its mining properties situated in Tennessee produced in 1902, according to the report of the directors to the stockholders, 8,163,534 pounds of copper, gross value, $1,024,450, which amounted to 1.3 per cent of the gross value of the output of all copper mines, as reported to the Bureau of the Census.

Next in importance after the Amalgamated Copper Company was the Calumet and Hecla Copper Company of Michigan. President Alexander Agassiz reported for the fiscal year ending April 30, 1903, a production of 38,316 long tons of fine copper, equal to 85,827,840 pounds.[1] The fine copper contents of the copper ores treated in the United States in 1902, as reported to the Bureau of the Census, amounted to 625,004,529 pounds. The production of the Calumet and Hecla Copper Company accordingly approximated 14 per cent of the total output of the copper mines of the United States.

The third place was held by the United Copper Company, which was organized in Montana under the corporate name of the Montana Ore Purchasing Company. The latter reported to the assessors of Silverbow county, Mont., for the fiscal year ended June 1, 1903, an output of 293,332 tons of ore having a gross value of $3,587,692. Mr. F. Augustus Heinze, president of the company, made the following statement to the press regarding the production of the company:

Production of the United Copper Company: 1902 and 1901.[1]

YEAR	Copper (pounds).	Silver (ounces).	Gold (ounces).
1902	30,371,690	919,209	11,999
1901	30,318,528	1,083,474	4,631

[1] The Commercial and Financial Chronicle, Vol. 76, pages 870 and 927.

Compared with the output of the copper mines of the United States, the production of the United Copper Company constituted 4.6 per cent of the total gross value, or 4.8 per cent of the fine copper contents.

An important group of mines was represented by 7 Michigan companies, which, though maintaining a separate corporate existence, were united under a common management through the ownership of the stock by the same group of stockholders. These were the Winona Copper Company, the Wolverine Copper Mining Company, the Mohawk Mining Company, the Atlantic Mining Company, the Baltic Mining Company, the Michigan Copper Company, and the Champion Copper Company. The total output of these companies, as shown in their published reports, yielded 25,237,594 pounds of fine copper having a gross value of $2,992,335, and constituted 4 per cent of the fine copper contents, or 3.8 per cent of the gross value reported at the census of 1902 for all copper mines.

The respective shares contributed by the above-named companies to the production of the United States are shown in the following statement:

Percentage production of eleven companies named of total: 1902.

COMPANY	Per cent of the output of United States.
Total	67
Amalgamated Copper Company	43
Tennessee Copper Company	1
Calumet and Hecla Copper Company	14
United Copper Company	5
Seven Michigan companies	4

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[1] The Commercial and Financial Chronicle, Vol. 77, page 193.

This list is not exhaustive; it does not include the United Verde Copper Company of Arizona and the Colusa-Parrott Copper Company of Montana, which are controlled by the same interests, and probably some other mines for which there are no available data. The properties enumerated in the preceding statement contribute two-thirds of the output of the United States.

The possibilities for further centralization are indicated by the location of the general offices of the mining companies. Of the 144 mines, 49 had their offices in the East—31 in New York and 18 in Boston. The output of these mines aggregated 463,445,212 pounds of copper out of a total output of 639,033,392 pounds; that is, 72 per cent of the production of the United States.

During the years 1900, 1901, and 1902, the output of the principal copper producers was handled by a joint selling agency—the United Metals Selling Company. This company was organized on January 29, 1900, and included among its incorporators two representatives of interests identified with the Amalgamated Copper Company. Its patronage, however, was not confined to that company alone. The company's charges were from 1.5 to 2.5 per cent for selling copper. Its total sales for 1902 were estimated by the Boston News Bureau at 545,000,000 pounds,[1] which amounted to 83 per cent of the output of refined copper for the year, as estimated by the United States Geological Survey.

In 1892 an association of copper producers, known as the American Producers' Association, was formed. It represented the following mines: Montana district, those of the Amalgamated Copper Company; Arizona district—Verde, Arizona, Queen, Detroit, Dominion; Lake Superior district—Calumet, Tamarack, Quincy, Osceola, Atlantic, Franklin, Tamarack, jr., Kearsarge, Wolverine, and Central.[2] Other companies joined the association subsequent to the date on which that list was compiled.[3] The association received from its members reports of the production of copper, which were compiled and published monthly. The production of the mines affiliated, as well as of those outside the association as contained in these reports, is shown in the following comparative statement:

American production of copper, as reported by the American Producers' Association: 1892 to 1902.

[Long tons.]

YEAR.	Total.	Reporting mines.	Outside sources.
Second six months of 1892	65,526	59,239	6,287
1893	142,490	129,760	12,730
1894	159,623	142,543	17,080
1895	171,197	155,497	15,700
1896	203,894	189,494	14,400
1897	216,106	204,206	11,900
1898	234,272	216,222	18,050
1899	262,206	230,806	31,400
1900	268,787	227,987	40,800
1901	265,255	223,355	41,900
1902	295,656	258,056	37,600

Early in 1903 large producing interests withdrew from the American Association, declining to furnish statistics, so that the monthly compilations have ceased.

It is worthy of note that the centralizing tendency in the operation of copper mines has been accompanied by a growing decentralization of property interests. This clearly appears from the following statement of the number of stockholders of copper mining companies of the Lake Superior district where the corporate form of organization has entirely superseded firm or individual ownership.

Number of shareholders in Lake copper companies: 1896 to 1902.[1]

YEAR.	Number of shareholders.	Refined copper produced, gross value.	PER CENT OF INCREASE SINCE 1896.	
			Number of shareholders.	Gross value
1896	6,598	$15,758,935	....	....
1897	7,208	16,580,843	9.2	1.9
1898	8,897	17,929,871	34.8	13.1
1899	11,072	26,098,392	67.8	65.6
1900	18,026	23,691,928	173.2	50.3
1901	20,665	26,038,571	213.2	65.2
1902	22,568	20,100,625	242.0	27.5

[1] The Copper Handbook, Vol. III, pages 573, 574, and 594. The production of 1902 is taken from Census returns. The percentages were computed in the Bureau of the Census.

Production on a small scale.—As may be inferred from the degree of concentration shown above, the day of copper mining on a small scale is past. A survival of old time methods was presented by 3 mines operated by waterpower. The more modern small gas or gasoline engine enabled 12 other mines to conduct operations on a small scale. A summary of these 15 mines, using waterpower or gas exclusively, is presented in the following table:

TABLE 30.—*Summary of mines using only water wheels, or gas or gasoline engines: 1902.*

Number of mines	15
Salaries	$31,043
Wages	$149,902
Contract work	$350
Miscellaneous expenses	$11,611
Cost of supplies and materials	$50,764
Tons of ore produced:	
Total mined	16,528
Sold	5,250
Treated	7,419
Gross value of ore sold or treated	$279,273
Copper contents:	
Pounds	2,634,000
Value	$256,451
Value of by-products:	
Silver	$18,416
Gold	$3,686
Lead	$720
Reduction charges, freight, etc	$108,321
Value of product at mine	$172,949
Expended in development work	$75,216
Average percentage of copper in the ore	10.4
Average value:	
Fine copper, cents per pound	9.7
Gross value per ton	$22.04
Average cost of reduction, per ton	$8.39

The total output of the 15 mines summarized in the preceding table amounted to $172,949 in value, to which should be added the sum of $75,216, representing the value of development work done during the year. The ore was exceptionally rich, yielding 10.4 per cent of fine copper. The average price realized per pound of copper was 9.7 cents, which brought $22.04 per ton of crude ore. The average cost of reduction amounted to

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[1] The Commercial and Financial Chronicle, Vol. 70, page 284; Vol. 76, page 334.

[2] Monthly Summary of Commerce and Finance of United States, May, 1900, page 3107.

[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 166.

$8.39 per ton, which left $13.65 per ton as value at mine, whereas the gross value of all copper ores mined and treated in the United States averaged only $6.79 per ton. It is probable that it was only the exceptionally high grade of the ore that made mining on so small a scale possible.

The world's production and the world's copper market.—The United States is to-day the chief producer of copper in the world; nearly two-thirds of the world's output in 1902 was furnished by the United States. The following table is a summary of the production of the copper mines of the world:

TABLE 31.—PRODUCTION OF COPPER MINES OF THE WORLD: 1879 TO 1902.[1]

[Long tons.]

	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891
Total for the world	542,470	518,788	484,790	472,244	429,626	399,730	373,368	334,565	324,505	303,530	310,472	279,391
Total for North America	349,870	318,640	301,237	290,971	260,846	237,135	220,948	189,720	178,365	162,730	165,825	138,919
United States	294,600	267,410	268,787	262,206	234,271	216,060	203,998	172,300	159,695	147,210	152,620	128,179
Canada and Newfoundland	19,485	20,800	10,400	9,430	10,140	7,705	5,800	5,800	6,900	7,040	5,890	5,540
Mexico	35,785	30,430	22,050	19,335	16,435	13,370	11,150	11,620	11,770	8,480	7,315	5,200
Total for South America	38,750	42,385	36,095	32,730	30,065	25,300	26,340	24,925	26,810	27,420	29,015	29,015
Argentina	240	85	75	65	125	200	100	150	230	160	200	210
Bolivia	2,000	2,000	2,100	2,500	2,050	2,200	2,000	2,250	2,300	2,500	2,950	2,150
Chile	28,930	30,780	25,700	25,000	24,850	21,900	23,500	22,075	21,340	21,350	22,565	19,875
Peru	7,580	9,520	8,220	5,165	3,040	1,000	740	450	440	460	200	280
Venezuela									2,500	2,950	3,100	6,500
Total for Europe	90,985	93,013	89,887	92,905	88,430	89,855	86,730	84,375	83,780	81,590	85,182	80,937
Austria-Hungary, including Bosnia and Servia	1,500	1,335	1,355	1,505	1,540	1,655	1,285	1,310	2,120	1,425	1,385	1,250
England	600	532	650	635	640	520	555	580	445	425	495	72
Germany	21,605	21,720	20,410	23,160	20,165	20,145	20,065	16,555	17,290	16,150	17,295	16,150
Italy	3,370	3,000	2,955	2,985	2,965	3,480	3,400	2,500	2,600	2,500	2,500	2,200
Russia	8,000	8,000	6,740	7,210	6,250	6,025	5,100	5,290	5,000	5,000	4,900	4,800
Sweden and Norway	5,020	3,825	1,385	4,130	4,097	3,995	3,000	3,200	2,240	2,390	2,145	1,902
Spain and Portugal	49,790	53,621	52,872	52,168	52,375	51,060	53,325	54,950	54,175	53,995	56,462	53,915
Turkey	1,100	980	320	925	470	975						
Asia (Japan)	29,775	27,475	27,840	28,310	25,175	23,000	21,000	18,430	20,050	18,000	18,000	17,000
Australia	28,640	30,875	25,020	20,750	18,000	17,000	11,000	10,000	9,000	7,500	6,500	7,500
Africa	4,450	6,400	6,720	6,490	7,110	7,440	7,450	7,115	6,500	6,000	5,950	6,020

	1890	1889	1888	1887	1886	1885	1884	1883	1882	1881	1880	1879
Total for the world	269,455	261,205	258,026	223,798	217,088	225,592	220,249	199,406	181,622	163,369	153,959	151,963
Total for North America	125,435	114,669	108,776	83,914	72,740	76,403	66,659	54,167	42,871	33,433	26,960	25,300
United States	116,325	105,774	101,710	79,109	69,805	74,050	64,700	51,570	40,470	30,882	25,010	23,350
Canada and Newfoundland	4,785	5,115	4,300	2,755	2,685	1,978	1,668	2,108	2,000	2,218	1,550	1,550
Mexico	4,325	3,780	2,766	2,050	250	375	291	489	401	333	400	400
Total for South America	33,960	31,478	37,090	33,570	40,088	44,573	48,260	47,485	51,108	44,309	47,616	53,815
Argentina	150	190	150	170	180	233	150	293	800	307	300	300
Bolivia	1,900	1,200	1,450	1,300	1,100	1,500	1,500	1,680	3,250	2,655	2,000	2,000
Chile	26,120	24,250	31,240	29,150	35,025	38,500	41,648	41,099	42,909	37,909	42,916	49,318
Peru	150	275	250	50	75	229	362	395	440	615	600	600
Venezuela	5,640	5,563	4,000	2,900	3,708	4,111	4,600	4,018	3,700	2,823	1,800	1,597
Total for Europe	80,990	83,898	85,560	80,214	76,433	77,516	75,961	72,554	66,243	65,960	60,245	54,620
Austria-Hungary, including Bosnia and Servia	1,510	1,525	1,868	1,414	1,099	1,165	1,270	1,290	1,115	1,270	1,290	1,145
England	905	905	1,456	999	1,471	2,773	3,350	2,620	3,464	3,875	3,662	3,462
Germany	17,625	17,356	15,230	11,875	14,465	15,250	14,762	14,643	13,316	12,742	10,800	9,000
Italy	2,200	3,500	3,500	2,500	2,100	2,000	2,000	1,600	1,400	1,480	1,380	1,140
Russia	4,800	4,070	4,700	5,000	4,875	5,100	4,700	4,400	4,000	3,700	3,300	3,300
Sweden and Norway	2,220	2,272	2,356	2,330	2,770	3,335	3,414	3,394	3,388	3,035	3,500	3,212
Spain and Portugal	51,700	54,270	56,450	53,706	49,633	47,873	46,415	44,607	39,560	39,258	36,313	33,361
Turkey												
Asia (Japan)	15,000	15,000	11,600	11,000	12,000	10,000	10,000	7,600	4,800	3,900	3,900	3,900
Australia	7,500	8,300	7,450	7,700	9,700	11,400	14,100	12,000	11,000	10,000	9,700	9,500
Africa	6,570	7,860	7,550	7,400	6,125	5,700	5,260	5,600	5,600	5,687	5,538	4,828

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[1] Compiled by Henry R. Merton & Co., Ltd., London; cited in Statistical Compilations of Lead, Copper, Spelter, Tin, Silver, Nickel, Aluminum and Quicksilver, by the Metallgesellschaft and the Metallurgische Gesellschaft A.-G., 1898, page 10, and 1903, pages 6 and 7.

As shown by the preceding table, North and South America, since 1882, have been the chief source of the world's supply of copper. While the production of South America has declined, North America as a copper producer has, since 1892, overshadowed the rest of the world. Since 1895 the mines of the United States alone have furnished more than one-half of the world's copper.

Among European producers the Iberian peninsula held the first place. Prior to 1882 its output exceeded the production of the United States, and, in 1882, both countries were on the same level, but within the following twenty years the production of Spain and Portugal increased by only about 25 per cent, while the production of the United States in 1902 was more than seven times as large as it was twenty years before.

Mexico, which prior to 1894 was but a small factor in the world's production of copper, has since that year more than trebled its output and gained third place among the copper producing countries.

Next after Mexico was Japan, which since 1890 has doubled its output, and Australia, whose progress has been still more rapid. Germany has shown no appreciable gains since 1896, and has been outranked by Mexico and Australia.

In the table which follows, the refined copper product of smelters and refineries of all countries since 1889, as compiled by the Metallgesellschaft and Metallurgische Gesellschaft A.-G., is compared with the copper contents of the output of all copper mines, as compiled by Henry R. Merton & Co., Limited.

Table 32.—*Copper output of mines and smelters of all countries: 1889 to 1902.*[1]

YEAR.	MINES.	SMELTERS.	
	Metric tons.	Metric tons.	Per cent of mine output.
Total	5,390,009	5,404,886	100.3
1889	265,384	267,192	100.7
1890	273,765	282,251	103.1
1891	283,861	291,225	102.6
1892	315,439	317,137	100.5
1893	309,387	308,700	99.8
1894	329,698	328,000	99.5
1895	339,919	351,500	103.4
1896	379,337	393,200	103.7
1897	406,126	418,900	103.1
1898	436,500	433,300	99.3
1899	479,800	480,000	100.0
1900	492,556	487,200	98.9
1901	527,089	517,550	98.2
1902[2]	551,148	532,700	96.7

[1] Cited in report by the Metallgesellschaft and Metallurgische Gesellschaft A.-G., 1903.

[2] Figures for United States exceed United States Census figures by 6,149,608 pounds. As the difference is less than 1 per cent, the estimate of Henry R. Merton & Co., Ltd., is retained for the sake of comparison.

The variations between the output of mines and smelters have been confined within narrow limits, viz, between 3.7 per cent above and 3.3 per cent below the mine output. This close agreement is due to the fact that copper is mostly mined and smelted by the same producers; either quantity may therefore be used for comparisons.

The following table shows the growth of the world's production of copper during the past century:

Table 33.—*Growth of the world's copper production in the nineteenth century.*[1]

[Long tons.]

DECADE.	World's production of each decade.	Increase of production over previous decades.	Average annual production for each decade.	Increase of average annual production.
1801 to 1810	91,000	....	9,100	
1811 to 1820	96,000	5,000	9,600	500
1821 to 1830	135,000	39,000	13,500	3,900
1831 to 1840	218,400	83,400	21,840	8,340
1841 to 1850	291,000	72,600	29,100	7,260
1851 to 1860	506,909	215,909	50,690	21,590
1861 to 1870	900,000	393,091	90,000	39,310
1871 to 1880	1,189,000	289,000	118,900	28,900
1881 to 1890	2,373,398	1,184,398	237,339	118,439
1891 to 1900	3,708,901	1,335,503	370,890	133,550

[1] The Copper Handbook, Vol. III, page 365.

A study of the table shows that during the first two decades of the past century the production of copper remained practically stationary. From 1820 to 1880 the average yearly production more than doubled once in every twenty years. Within the last two decades of the century the annual average production more than trebled, increasing from 118,900 tons during the years from 1871 to 1880 to 370,890 tons from 1891 to 1900. The annual average output from 1881 to 1890 exceeded the average for the preceding decade by 118,439 tons, i. e., by 99.6 per cent, and the annual average for the years from 1891 to 1900 showed an increase over the preceding decade amounting to 133,551 tons, or 56.3 per cent. Though the increase in production during the last decade was absolutely greater than during the preceding period, yet owing to the enlarged volume of production the relative increase appears smaller.

The extraordinary progress of copper mining within the last two decades was stimulated by the rapid extension of the uses of electricity to all branches of industry. The United States has been the chief factor in this progress. The production of the United States increased from 1879 to 1902 more than twelvefold. The share of the United States in the progress of copper mining is shown in the following comparative summary by quadrennial periods:

Table 34.—OUTPUT OF COPPER MINES OF THE UNITED STATES AND OTHER COUNTRIES, BY QUADRENNIAL PERIODS: 1879 TO 1902.[1]

[Long tons.]

PERIOD.	TOTAL PRODUCTION.				INCREASE OVER PRECEDING PERIOD.			
	All countries.	United States.	Other countries.	Per cent United States.	All countries.	United States.	Other countries.	Per cent United States.
1879 to 1882	650,913	119,712	531,201	18.4	....	....	....	....
1883 to 1886	862,333	260,125	602,208	30.2	211,420	140,413	71,007	66.4
1887 to 1890	1,012,484	402,918	609,566	39.8	150,151	142,793	7,358	95.1
1891 to 1894	1,217,898	587,704	630,194	48.3	205,414	184,786	20,628	90.0
1895 to 1898	1,537,284	826,524	710,760	53.8	319,386	238,820	80,566	74.8
1899 to 1902[2]	2,018,391	1,093,093	925,298	54.2	481,017	266,479	214,538	55.4

[1] Henry R. Merton & Company's figures, cited in the report by the Metallgesellschaft and Metallurgische Gesellschaft A. G., October, 1903.

[2] Figures for United States exceed United States Census figures by 6,149,608 pounds. As this is less than 1 per cent the estimate of Henry R. Merton & Co., Ltd., is retained for sake of comparison.

Up to the period from 1895 to 1898 the United States was rapidly gaining over all other countries. From 1887 to 1894 practically all the increase in the world's production of copper came from the United States. During the years from 1895 to 1898 the United States outranked all other countries. During the last period, closed by the census year 1902, the production of the United States maintained its rate of growth, but mining in other countries took on a new life under the stimulus of high prices, as will be shown below, and the increase in their output nearly reached that of the United States.

In Table 35 the world's production and consumption of copper are shown since the year 1895, when the United States surpassed the total production of all other countries. All countries are arranged in two classes: (1) Those whose domestic consumption of refined copper exceeded the output of their own mines, and (2) those whose mines produced more than was consumed at home. For the sake of brevity, the former are designated as "importing countries" and the latter as "exporting countries."

It must be understood, however, that some of the countries designated here as "importing" also exported considerable quantities of copper, while those designated as "exporting" may have imported copper ore, matte, etc., to be later reexported as refined copper. In calculating the domestic consumption for each country its imports are added to its production, and its exports are deducted from the total; the increase or decrease of the stocks of copper from year to year is also taken into account wherever ascertainable. The estimate of domestic consumption which is arrived at in this manner represents the supply of copper available for domestic consumption, but is not necessarily identical with the quantity actually consumed in manufactures for which copper serves as material.

In Table 35 the column headed "product of mines" represents only the production of copper from domestic ores, as reported by Henry R. Merton & Co., Ltd.; the column "consumption" represents the supply available from all sources for domestic consumption, as computed by the Metallgesellschaft and Metallurgische Gesellschaft A.-G.; the "net demand for imported copper" in the list of importing countries and the "net supply available for export" in the list of exporting countries represents, in each case, the difference between the totals of the two columns just mentioned. The table thus shows, on the one hand, the share contributed by each copper mining country to the world's supply of copper, and on the other hand the demand for unmanufactured copper directly exercised by the manufacturing industries of each country.

TABLE 35.—WORLD'S PRODUCTION AND CONSUMPTION OF COPPER, BY COUNTRIES: 1895 TO 1902.

[Long tons.]

	1902			1901			1900			1899		
IMPORTING COUNTRY.	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.
Total	35,075	328,635	293,560	34,787	279,225	244,438	32,110	317,148	285,038	35,775	276,620	240,845
Great Britain	600	118,638	118,038	532	103,552	103,020	650	107,034	106,384	635	85,137	84,502
Germany	21,605	100,324	78,719	21,720	82,243	60,523	20,410	107,176	86,766	23,460	96,094	72,634
France	......	52,060	52,060		42,382	42,382		51,780	51,780		48,442	48,442
Austria-Hungary	1,500	18,862	17,362	1,535	17,926	16,391	1,355	19,382	18,027	1,505	16,855	15,350
Russia	8,000	17,219	9,219	8,000	13,873	5,873	6,740	13,972	7,232	7,210	13,578	6,368
Italy	3,370	10,218	6,848	3,000	9,214	6,214	2,955	8,211	5,256	2,965	7,560	4,595
Belgium	....	6,592	6,592	....	6,395	6,395	......	6,150	6,150	......	5,412	5,412
Netherlands	......	2,361	2,361	......	2,361	2,361	......	2,361	2,361		2,361	2,361
Exports from Europe	...	2,361	2,361	...	1,279	1,279	...	1,082	1,082	...	1,181	1,181
EXPORTING COUNTRY.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.
Total	507,395	218,063	289,332	484,201	247,261	236,940	452,689	163,413	289,276	436,469	196,674	239,795
North America:												
United States	294,600	199,959	94,641	267,410	236,733	30,677	268,787	151,427	117,360	262,206	185,851	76,355
Canada and Newfoundland	19,485	...	19,485	20,800	......	20,800	10,400	...	10,400	9,430	......	9,430
Mexico	35,785	......	35,785	30,430	....	30,430	22,050	....	22,050	19,335	....	19,335
South America:												
Chile	28,930	....	28,930	30,780	....	30,780	25,700	....	25,700	25,000	....	25,000
Other South American countries[1]	9,820	....	9,820	11,605	....	11,605	10,395	....	10,395	7,730	....	7,730
Europe:												
Sweden and Norway	5,020	2,853	53,057	3,825	2,558	55,868	4,385	2,066	55,711	4,130	1,968	55,250
Spain and Portugal	49,790			53,621			52,872			52,168		
Turkey	1,100			980			520			920		
Asia: Japan	29,775	15,251	43,164	27,475	7,970	50,380	27,840	9,920	40,940	28,310	8,855	40,205
Australia	28,640			30,875			23,020			20,750		
Africa	4,450	.....	4,450	6,400	.....	6,400	6,720	....	6,720	6,490	....	6,490

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[1] Includes Argentina, Bolivia, and Peru.

TABLE 35.—WORLD'S PRODUCTION AND CONSUMPTION OF COPPER, BY COUNTRIES: 1895 TO 1902—Continued.

IMPORTING COUNTRY.	1898			1897			1896			1895		
	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.	Product of mines.	Consumption.	Net demand for imported copper.
Total	31,490	299,703	268,213	31,825	300,572	268,747	30,405	284,166	253,761	26,225	232,080	205,855
Great Britain	640	102,696	102,056	520	107,771	107,251	555	114,799	114,244	580	90,080	89,500
Germany	20,085	95,455	75,370	20,145	88,355	68,210	20,065	78,161	58,096	16,555	62,787	46,232
France		48,756	48,756		51,035	51,035		42,529	42,529		37,560	37,560
Austria-Hungary	1,540	18,313	16,773	1,655	16,917	15,262	1,285	14,566	13,281	1,310	12,665	11,355
Russia	6,260	17,219	10,959	6,025	19,187	13,162	5,100	18,006	12,906	5,280	13,775	8,495
Italy	2,965	7,671	4,706	3,480	7,665	4,185	3,400	6,856	3,456	2,500	6,584	4,084
Belgium		5,707	5,707		6,100	6,100		5,412	5,412		1,920	1,920
Netherlands		2,361	2,361		2,361	2,361		2,361	2,361		2,361	2,361
Exports from Europe		1,525	1,525		1,181	1,181		1,476	1,476		1,378	1,378

EXPORTING COUNTRY.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.	Product of mines.	Kept for domestic consumption.	Net supply available for export.
Total	398,135	137,086	261,050	367,905	120,135	247,770	342,958	109,773	233,185	308,340	126,075	182,265
North America:												
United States	234,271	121,933	112,338	216,060	104,294	111,766	203,893	94,424	109,469	172,300	116,433	55,867
Canada and Newfoundland	10,140		10,140	7,705		7,705	5,800		5,800	5,800		5,800
Mexico	16,435		16,435	13,370		13,370	11,150		11,150	11,620		11,620
South America:												
Chile	24,850		24,850	21,900		21,900	23,500		23,500	22,075		22,075
Other South American countries[1]	5,215		5,215	3,400		3,400	2,840		2,840	2,850		2,850
Europe:												
Sweden and Norway	4,095	1,673	55,267	3,995	1,968	56,062	3,000	2,263	54,062	3,200	1,771	56,379
Spain and Portugal	52,375			53,060			53,325			54,950		
Turkey	470			975								
Asia (Japan)	25,175	13,480	29,695	23,000	13,873	26,127	21,000	13,086	18,914	18,430	7,871	20,559
Australia	18,000			17,000			11,000			10,000		
Africa	7,110		7,110	7,440		7,440	7,450		7,450	7,115		7,115

[1] Includes Argentina, Bolivia, and Peru.

The recapitulation which follows shows the share of the world's output consumed at home and exported; the domestic consumption is obtained by adding the production of importing countries to the domestic consumption of exporting countries.

TABLE 36.—*World's production, domestic consumption, and supply available for export, with per cent of total production: 1895 to 1902.*

[Long tons.]

YEAR.	Total production.	Domestic consumption.	Net supply available for export.	PER CENT OF PRODUCTION.	
				Domestic consumption.	Net supply available for export.
Total	3,555,585	1,575,972	1,979,613	44.3	55.7
1895	334,565	152,300	182,265	45.5	54.5
1896	373,363	140,178	233,185	37.5	62.5
1897	399,730	151,960	247,770	38.0	62.0
1898	429,626	168,576	261,050	39.2	60.8
1899	472,244	232,449	239,795	49.2	50.8
1900	484,799	195,523	289,276	40.3	59.7
1901	518,788	281,848	236,940	54.3	45.7
1902	542,470	253,138	289,332	46.7	53.3

Tables 35 and 36 bring out the fact that copper is preeminently an article of international trade. More than one-half of the copper mined was exported for consumption to other countries. With the exception of the United States, the principal producers of copper had practically no market for it at home. The United States, though holding the first place among the consumers of copper, was also largely dependent upon the foreign market for the sale of the product of its mines.

There is a difference amounting from a fraction of 1 per cent to over 10 per cent between the total net supply available for export and the total net demand for imported copper. The variance is due in part to the well-known disagreement between export and import statistics and partly to the fact that the resmelting of old copper enters into the calculation of the consumption for some countries.

On the whole, the copper mines of the United States have since 1895 supplied over one-third of the demand for imported copper, as shown in the following table:

TABLE 37.—*Consumption of copper in importing countries and exports of domestic copper from the United States: 1895 to 1902.*

[Long tons.]

YEAR.	Importing countries' net demand for imported copper.	Available for export in the United States.	Supplied by other countries.
Total	2,060,638	708,473	1,352,165
1895-1898	996,556	389,440	607,116
1899-1902	1,064,082	319,033	745,049
1895	205,855	55,867	149,988
1896	253,761	109,469	144,292
1897	268,747	111,766	156,981
1898	268,213	112,338	155,875
1899	240,845	76,355	164,490
1900	285,038	117,360	167,678
1901	244,639	30,677	213,962
1902	293,560	94,642	198,919

The principal consumers of copper besides the United States were Great Britain, Germany, and France. The same countries were also the principal importers of copper, while the United States, Spain, and Portugal were the principal exporters of domestic copper. Next after Spain and Portugal as exporters of domestic copper followed, in consecutive order, Mexico, Chile, Japan, Australia, and Canada.

Europe being the principal market for copper, a comparative table is next presented showing in parallel columns the gross exports to Europe from other continents, the net supply of domestic copper available for export, and the excess of the one over the other.

TABLE 38. TRADE OF THE PRINCIPAL EXPORTING COUNTRIES WITH EUROPE: 1895 TO 1902.

[Long tons.]

EXPORTING COUNTRY.	1902				1901			
	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.
Total	231,825	226,599	73,130	67,904	174,672	164,415	71,381	61,124
North America:								
United States	94,641	162,545		67,904	30,677	91,801		61,124
Canada and Newfoundland	19,485	9,839	45,431		20,800	8,659	42,571	
Mexico	35,785				30,430			
South America:								
Chile	28,930	21,942	6,988		30,780	23,024	7,756	
Other South American countries	9,820		9,820		11,605		11,605	
Asia (Japan)	43,164	14,169	10,891		50,380	20,367	9,449	
Australia		18,104				20,564		

EXPORTING COUNTRY.	1900				1899			
	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.
Total	226,845	217,546	42,972	33,673	178,055	176,222	36,564	34,731
North America:								
United States	117,360	151,033		33,673	76,355	111,086		34,731
Canada and Newfoundland	10,400	11,315	21,135		9,430	11,118	17,587	
Mexico	22,050				19,275			
South America:								
Chile	25,700	19,482	6,218		25,000	16,825	8,175	
Other South American countries	10,395		10,395		7,790		7,790	
Asia (Japan)	40,940	18,596	5,224		40,205	20,663	3,012	
Australia		17,120				16,530		

EXPORTING COUNTRY.	1898				1897			
	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.
Total	198,673	194,819	31,923	28,069	184,268	178,288	18,189	12,209
North America:								
United States	112,338	140,407		28,069	111,766	123,975		12,209
Canada and Newfoundland	10,140	10,036	16,549		7,705	15,251	5,824	
Mexico	16,445				13,370			
South America:								
Chile	24,850	17,711	7,139		21,900	17,711	4,189	
Other South American countries	5,215		5,215		3,400		3,400	
Asia (Japan)	29,685	12,201	3,020		26,127	11,118	4,776	
Australia		14,464				10,233		

EXPORTING COUNTRY.	1896				1895			
	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.	Domestic supply available for export.	Actual exports to Europe.	Excess of—Domestic supply over exports to Europe.	Excess of—Exports to Europe over available supply.
Total	171,673	162,576	15,436	6,339	118,771	103,509	15,262	
North America:								
United States	109,469	115,808		6,339	55,867	54,214	1,653	
Canada and Newfoundland	5,800	11,217	5,733		5,800	10,725	6,695	
Mexico	11,150				11,620			
South America:								
Chile	23,500	18,596	4,904		22,075	19,285	2,790	
Other South American countries	2,840		2,840		2,850		2,850	
Asia (Japan)	18,914	8,855	1,959		20,559	11,315	1,274	
Australia		8,100				7,970		

The preceding table clearly shows the place of each producing country in the world's copper trade. Beginning with the year 1896, the United States showed a growing excess of exports to Europe over its domestic supply, whereas in all other copper producing countries the supply available for export exceeded the direct exports to Europe. The excess of the exports from the United States in 1901 and 1902 was very near the surplus of all other countries, after deducting their direct exports to Europe. These figures demonstrate that the United States has within late years gained control of the export trade of non-European copper producing countries.

A closer study of the statistics shows that the direct exports to Europe from Canada and Mexico have fallen off slightly, while the supply of copper available in these countries for export has more than trebled since 1895. All this copper found its way to the United States, to be reexported to Europe. The direct exports to Europe from Canada and Mexico are but a minor portion of their total copper exports. The United States has also a fair share of the copper trade of Japan, Australia, and Chile, though these countries for the most part maintain direct relations with Europe.

The share of the United States in each of the principal European copper markets, namely, Great Britain, Germany, and France, is shown in the following table. The imports reported by these countries from the United States represent actual exports from this country, both of domestic and foreign copper.

TABLE 39.—COPPER CONSUMPTION OF GREAT BRITAIN, GERMANY, AND FRANCE, AND IMPORTS FROM THE UNITED STATES: 1895 TO 1902.

[Metric tons.]

YEAR.	GREAT BRITAIN.			GERMANY.			FRANCE.		
	Consumption.[1]	Imported from the United States.[2]	Supplied from other sources.	Consumption.[1]	Imported from the United States.[2]	Supplied from other sources.	Consumption.[1]	Imported from the United States.[2]	Supplied from other sources.
1895	91,551	20,923	70,628	63,813	31,311	32,502	38,174	11,999	26,175
1896	116,674	40,446	76,228	79,438	42,504	36,934	43,224	22,357	20,867
1897	109,531	33,387	76,144	89,798	50,420	39,378	51,869	26,592	25,277
1898	104,373	39,608	64,765	97,014	52,473	44,541	49,552	23,125	26,427
1899	86,528	21,438	65,090	97,664	47,742	49,922	49,233	25,098	24,135
1900	108,782	32,557	76,225	108,927	66,264	42,663	52,626	29,575	23,051
1901	105,243	21,761	83,482	84,840	42,422	42,418	43,074	14,237	28,837
1902	120,576	44,345	76,231	101,963	60,274	41,689	52,909	29,936	22,973

[1] From the Metallgesellschaft and Metallurgische Gesellschaft A.-G., 1903, page 9.
[2] From United States Geological Survey, "Mineral Resources of the United States," 1902, pages 193 and 195.

Germany was the largest European consumer of American copper. The German copper market depended upon the United States for more than one-half of its supply, the balance being furnished by the German mines and by imports from other countries. The second place among the consumers of American copper was held by Great Britain; the position of American copper in the English market was important, yet far from dominant. The French market has, since 1896, developed a large demand for American copper; in 1902 two-thirds of the copper consumed in France was imported from the United States.

International organization among producers.—The degree of concentration which has been noted in the United States was also characteristic of the copper mining industry in other countries.

In Spain the two largest mines, the Rio Tinto and the Tharsis, were operated by English corporations, the former being controlled by the Rothschild interests.[1] The Rio Tinto produced in 1901, 79,279,520 pounds of fine copper, and the Tharsis 16,636,480 pounds. They furnished four-fifths of the production of Spain.

In Mexico the two largest mining companies were the Greene Consolidated Copper Company, an American corporation, and the Compagnie du Boleo, supposed to be controlled by the French house of the Rothschilds.[2] The former reported, for the year ending August 1, 1902, a product of 27,854,497 pounds of fine copper in matte and bullion,[3] and the latter produced in 1901, 24,153,197 pounds.[4] The combined production of these two mines represented two-thirds of the total output of Mexico.

In Germany the Mansfeld mines produced in 1901 42,067,200 pounds of copper, which was practically all the copper produced in Germany.

The concentration of the copper mining industry under the control of a limited number of companies facilitated organization among them. The first attempt at organization was the Secretan syndicate, which was formed in Paris in the fall of 1887, with the object of improving the price of copper. The syndicate was organized with a capital stock of 100,000,000 francs, divided into shares of 1,000,000 francs each. In October, 1887, fine copper was quoted in London at from £39 to £40 per ton. The syndicate made contracts with mining companies in all parts of the world for their entire supply at prices ranging from £68 to £70 per ton.

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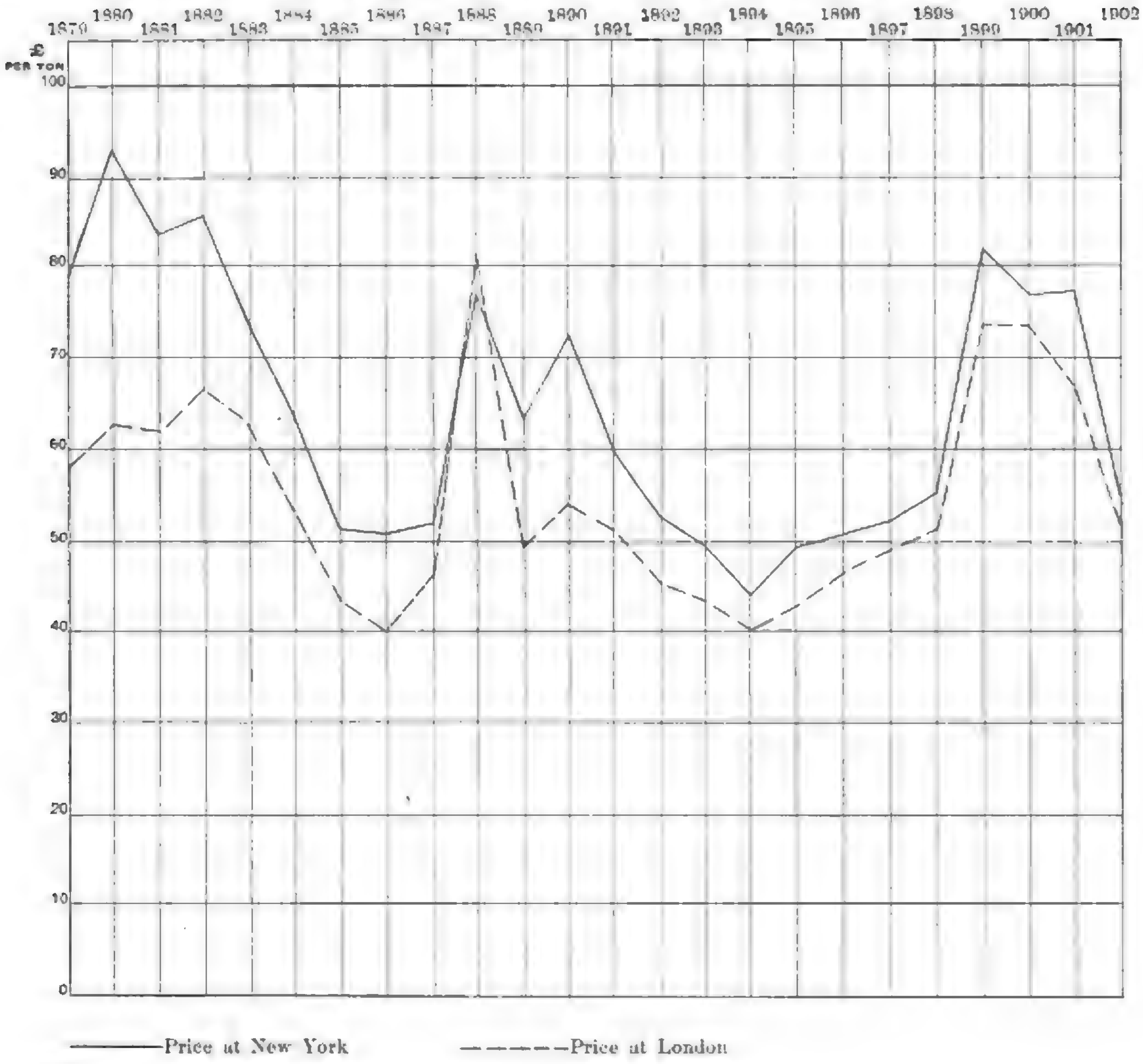
[1] The Copper Handbook, Vol. III, pages 471 and 512; The Truth about the Trusts, by John Moody, page 40.

[2] The Copper Handbook, Vol. III, pages 471 and 512; The Truth about the Trusts, page 211.

[3] Annual Report of the Greene Consolidated Copper Company, 1902.

[4] The Copper Handbook, Vol. III, page 566.

DIAGRAM I.—AVERAGE PRICES OF COPPER, NEW YORK AND LONDON, 1879 TO 1902.



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The price of copper immediately took an upward course and was soon driven as high as £100 per ton. High prices stimulated the extension of mining, and the output was greatly increased. In order to sustain the price the syndicate was compelled to buy all copper that was offered to it. On the other hand, consumers reduced their stock to the lowest limit, preferring to buy from day to day. As a result, the visible stock of copper rapidly increased, rising from 42,301 tons on January 1, 1888, to 104,105 tons a year later. Though it was financed by one of the leading French banks, La Banque de Paris et de Pays Bas, and had the support of the Bank of France, the scheme finally collapsed, ending in the bankruptcy of the syndicate.[1]

In 1892 an organization was created, known as the European Producers' Committee. It represented the principal mines of Spain and Portugal, Germany, the Cape Colony, Mexico, and Australia, and was managed by European boards of directors. The mines have reported their output each month to a secretary in London since July, 1892.[2] As previously stated, simultaneously with the European organization, the American Producers' Association was organized, and both organizations maintained friendly relations and exchanged monthly reports with each other. The share of the world's output which was controlled by these two organizations is shown in the following table:

TABLE 40.—*World's production and output of American and foreign reporting mines: 1893 to 1902.*

[Long tons.]

YEAR.	World's production.[1]	PRODUCTION OF REPORTING MINES.			
		American.[2]	Foreign.[2]	Total.	
				Quantity.	Per cent of world's product.
1893	303,530	142,490	81,785	224,275	73.9
1894	324,505	159,623	88,531	248,154	76.5
1895	334,565	171,197	86,178	257,375	76.9
1896	373,363	203,894	86,196	290,090	77.7
1897	399,730	216,106	88,270	304,376	76.1
1898	429,626	234,272	84,554	318,826	74.2
1899	472,211	262,206	89,240	351,446	74.4
1900	484,799	268,787	89,431	358,218	73.9
1901	518,788	265,255	100,241	365,496	70.5
1902	542,170	295,656	108,875	404,531	74.6

[1] From compilation by Henry R. Merton & Co., Limited.
[2] From United States Geological Survey, "Mineral Resources of the United States," 1902, pages 166 and 167.

In 1903 large producing interests withdrew from the American Association, declining to furnish statistics in the future, so that the monthly compilations have ceased.[3] Considering that the United States supplies two-thirds of the copper product of the world, the termination of the understanding between American producers means that the international organization among copper producers, which was represented by the two associations, has practically come to an end.

Prices.—The price of copper governing in the United States is the New York price for Lake copper, the price of electrolytic copper, being usually from one-eight to one-fourth of a cent lower; the price ruling in the international market is the London price for standard copper. Table 41 is a comparative table showing the average annual prices of copper in New York and London since 1879.

TABLE 41.—*Average prices of copper, London and New York: 1879 to 1902.*[1]

YEAR.	Standard copper at London, price per long ton.			LAKE COPPER AT NEW YORK.	
				Cents per pound.	English equivalent £ per long ton.
	£	s.	d.		
1879	58	8	9	17⅛	79
1880	62	11	7	20⅛	93
1881	61	16	9	18⅛	83⅜
1882	66	10	5	18⅝	85⅜
1883	62	17	11	15⅞	73⅛
1884	53	17	6	13⅞	64
1885	43	11	0	11⅛	51¼
1886	40	1	8	11	51
1887	46	0	5	11¼	52
1888	81	11	3	16⅝	77
1889	49	14	8	13¾	63¼
1890	54	5	3	15¾	72½
1891	51	9	4	12⅞	59½
1892	45	13	2	11½	53
1893	43	15	6	10¾	49½
1894	40	7	4	9½	43¾
1895	42	19	7	10¾	49¼
1896	46	18	1	10⅞	50¼
1897	49	2	7	11¼	52¼
1898	51	16	7	12	55¼
1899	73	13	9	17⅝	82
1900	73	12	6	16.70	77
1901	66	19	8	16.77½	77¼
1902	52	11	5	11.97½	55¼

[1] "Comparative Statistics of Lead, Copper, etc.," compiled by the Metallgesellschaft and Metallurgische Gesellschaft A.-G., October, 1903, page 10.

The movement of prices is illustrated by Diagram I. The solid line representing the New York price runs above the broken line representing the London price, with the single exception of the year 1888, when the London price, by a sudden bound, rose to heights never witnessed either before or since within the last two decades. Although the New York price promptly responded, yet for once it stopped below the London price. The reason for this extraordinary rise was the attempted corner of the London market by the Secretan syndicate. The failure of the scheme drove the London price down; the New York price also receded, yet not quite as low, and the former relative position was restored.

The opening of copper mines in Montana and Arizona resulted in a downward tendency of prices from 1882 to 1886, which is shown by the movement of both lines in the diagram. A slight improvement marked the year 1890, after which a downward movement set in

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[1] Le Journal des Économistes, Vol. XLV, 1889, page 425; L'Économiste Français, March 9, 1889, page 289.
[2] Monthly Summary of Commerce and Finance of the United States, May, 1900, page 3107.
[3] United States Geological Survey, "Mineral Resources of the United States," 1902, page 167.

DIAGRAM II—PRODUCTION, CONSUMPTION, AND EXPORTS OF COPPER IN THE UNITED STATES: 1895 TO 1902

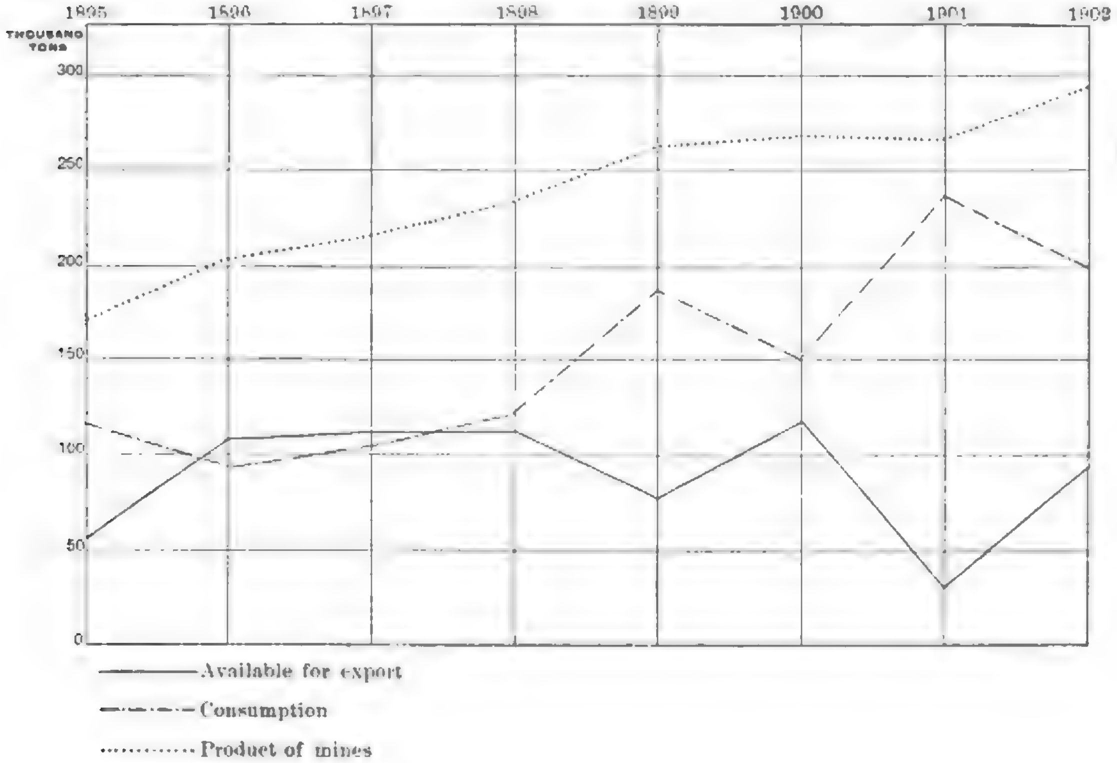
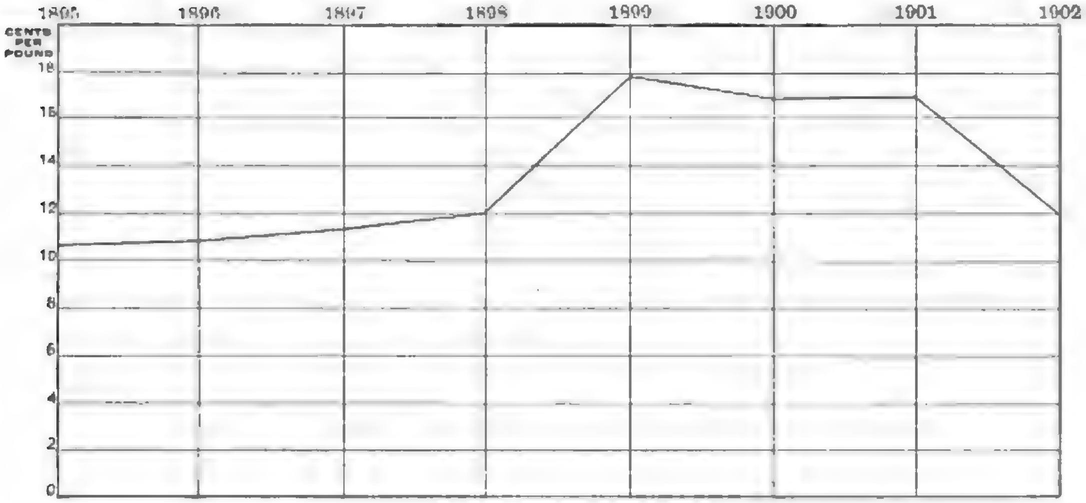


DIAGRAM II A—AVERAGE NEW YORK PRICES OF COPPER 1895 TO 1902



again, which touched its lowest point in 1894. The lines then take again an upward course.

The diagram also makes possible a study of the effect of organization among producers upon the movement of prices. Since 1892 the copper producers have kept informed from month to month concerning the output of the principal copper mines in all parts of the world. The output of the mines outside of the European and American associations did not exceed one-fourth of the world's production of copper. Thus the principal mines have been enabled to adjust their production with regard to the general state of the copper supply. The diagram shows that this knowledge of the demand and supply has not had the effect of steadying the prices; the range of fluctuations in New York and London since 1892 has been as wide as it was prior to that year. The difference between the New York and the London price shown by the distance between the solid and the broken lines has somewhat narrowed and, through all the vicissitudes of the market, has been less subject to fluctuation than before 1892.

In 1899 the Amalgamated Copper Company was organized. According to an official statement issued by the company, it adopted from the beginning the "policy of maintaining a firm price." Its selling agents were therefore "instructed not to attempt to force upon the market more than was actually needed for consumption, but to maintain a firm price."[1] The price was raised from 12 cents to 17 cents in 1899 and was maintained, with a slight reduction, until December, 1901, when the company was forced to reduce the price to the former level of 12 cents. The reason given for this reduction was the failure of other copper producing companies to take the same view of the situation and to maintain a firm price by restricting their output. The effect of this policy upon the copper trade can be studied from the preceding tables and the diagrams illustrating the same.

Diagrams II and II$_A$ show the production of copper in the United States, the supply held for domestic consumption, the domestic supply available for export, and the average New York prices of copper from 1895 to 1902. The upward movement of the solid line in Diagram II$_A$, representing the New York price, is followed by a similar movement of the dotted line in Diagram II representing the copper output of the mines in the United States. The solid line in Diagram II representing the net domestic supply available for export moves in the opposite direction; the rise of prices in 1899 is shown to have been accompanied by a decrease of exports; in 1900 a slight reduction in the price was attended by an increase of exports; in 1901 the price was maintained, but the exports sank to the lowest point; in 1902 the slump in the price was followed by an increase of the exports. The solid line in Diagram II$_A$ representing prices and the dash-and-dot line representing in Diagram II the amount of the domestic product held at home and available for domestic consumption run almost parallel.

The movements of the solid line in Diagram II$_A$ and of the dotted line in Diagram II indicate that the high prices of 1899 to 1901 stimulated production. In order to maintain a firm price it was necessary to reduce exports, which resulted in an increase of the supply available for domestic consumption.

The relation between the available supply and the actual demand for domestic consumption in 1900, 1901, and 1902 is shown in the data published by the United States Geological Survey. The available supply is computed by adding the production of domestic copper and imports of copper in ore, matte, bars, etc., entered for consumption, and by deducting from the sum the exports of copper. The demand, or estimated consumption, is obtained by deducting the increase in producers' stocks from the available supply, or by adding to it the decrease in producers' stocks. The following statement shows the relation of supply and demand to prices:[2]

Supply and demand and prices in the United States: 1900 to 1902.

YEAR.	Supply (pounds).	Demand (pounds).	Excess of supply over demand (pounds).	Excess of demand over supply (pounds).	PRICE OF LAKE COPPER IN NEW YORK (CENTS PER POUND).	
					Highest.	Lowest.
1900	362,891,121	356,891,121	6,000,000	....	17¼	16
1901	517,761,014	382,761,014	135,000,000	....	17	12¾
1902	425,339,486	551,688,131	....	126,348,645	13¾	10¾

In 1900 the copper producers managed to keep the supply close to the limits of demand; the price was maintained between 16 and 17¼ cents per pound. In 1901 the domestic demand remained almost stationary, but the supply increased enormously, which was due to a reduction in the foreign exports. In the face of this increased supply the price was for fully eleven months held at the same level as during the year before, and only in December, 1901, was it reduced to 12¾ cents. Except for a brief slump to 10¾ cents in January, 1902, and a rise to 13¾ in February, the price during the year fluctuated between 11½ and 12¾ cents, and at these prices nearly all of the surplus was absorbed in the domestic market; the demand in 1902 exceeded by 44 per cent that of the previous year.

The effect of high prices upon the American trade with Europe is shown in Diagram III. The solid line representing the net demand for imported copper and the dotted line representing the share supplied by the United States run almost parallel. An increase of the demand in Europe, as here represented, increases imports from the United States; a slackening of the demand reduces imports from the United States. At

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[1] The Commercial and Financial Chronicle, Vol. 73, page 1314.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 188 and 189.

DIAGRAM III.—EUROPEAN DEMAND FOR IMPORTED COPPER
1895 TO 1902.

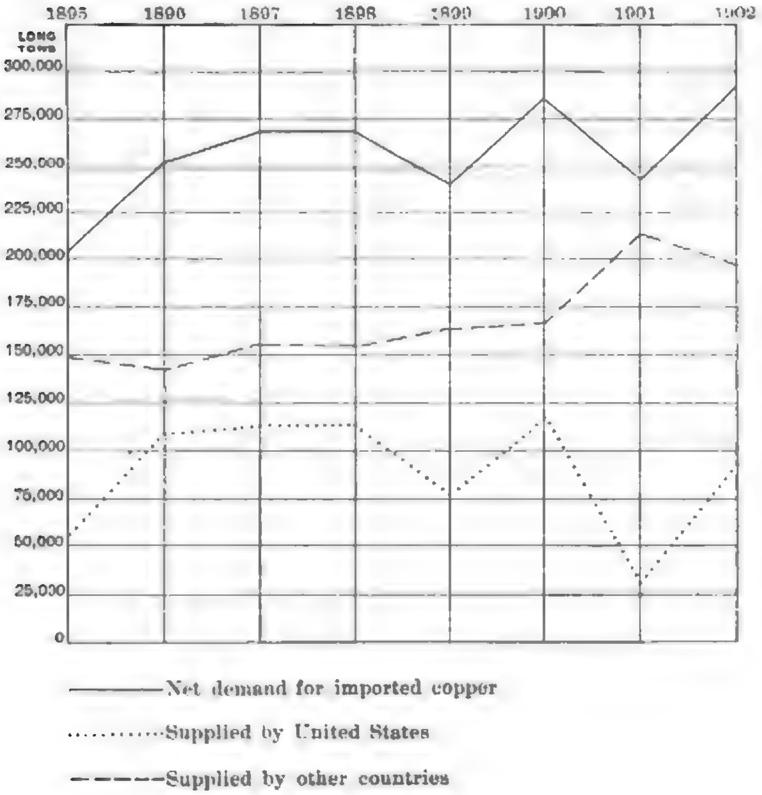


DIAGRAM IV.—CONSUMPTION OF IMPORTED COPPER IN GREAT BRITAIN, IMPORTS FROM THE UNITED STATES AND OTHER COUNTRIES 1895 TO 1902.

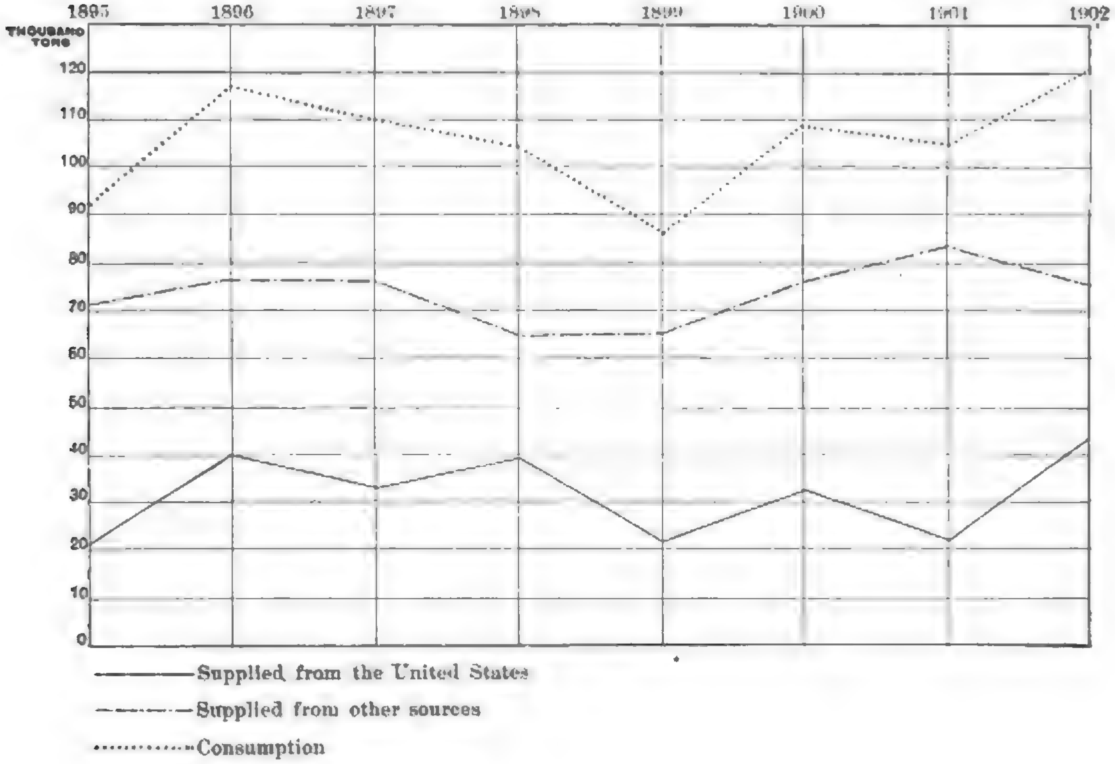


DIAGRAM IV A.—AVERAGE LONDON PRICES OF COPPER, 1895 TO 1902.

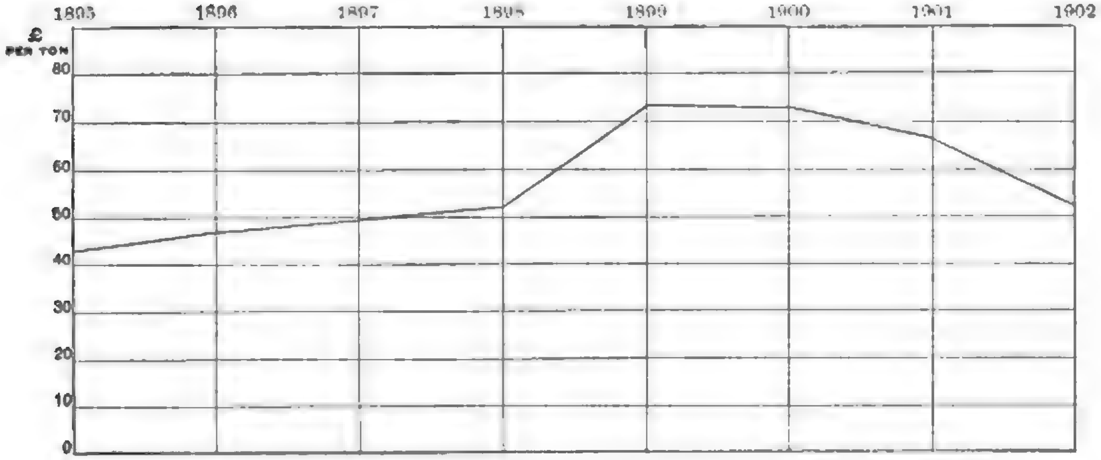


DIAGRAM V.—CONSUMPTION OF COPPER IN FRANCE: 1895 TO 1902.

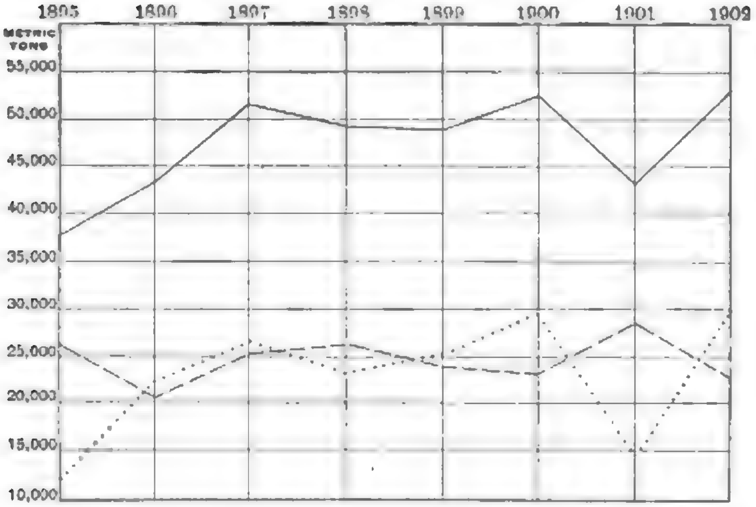
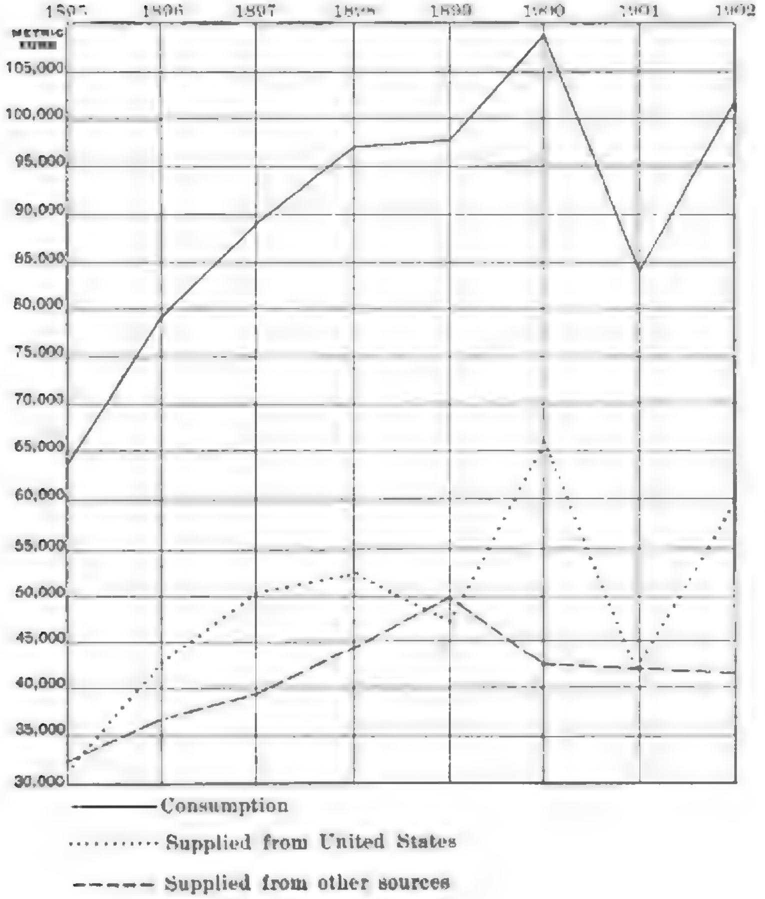


DIAGRAM VI.—CONSUMPTION OF COPPER IN GERMANY: 1895 TO 1902.



the same time, with reduced exports from the United States, the line of dashes representing the imports from other countries is slowly rising; in 1901, notwithstanding the fall in the European demand, the line suddenly goes up, while imports from the United States show a heavy decline. The rise of the demand and a parallel rise of the imports from America in 1902 are accompanied by a decline in the imports from other sources.

A comparison of the totals for the quadrennial periods 1895 to 1898 and 1899 to 1902 (see Table 37) shows that while the European demand rose from 996,556 to 1,064,082 long tons, the imports from the United States fell from 389,440 to 319,033 tons.

The effect of the latest price movement upon the American export trade was not alike in the principal European markets.

Diagrams IV and IV_A illustrate the correlation between the London price, the consumption in Great Britain, and the imports from the United States and other countries. The results appear to be the same as shown for Europe as a whole. In the French market the decline of American imports, as shown in Diagram V, created somewhat of an increase in the imports from other countries, not, however, corresponding to the shortage of the former. Diagram VI shows for Germany a parallel movement between the consumption of that country and the imports from the United States; yet the decline of American imports in 1901 did not increase the imports from other countries.

While the effect of high prices from 1899 to 1901 upon the export trade may appear unfavorable, yet it was declared by the Amalgamated Copper Company, in its official statement, that "the portion of the copper which has been sold has realized a larger profit than would have been realized had all the copper which had been produced been sold at a much lower price." This view is borne out by the following comparison of the production, prices, and dividends for the years 1895 to 1902:

Production, prices, and dividends: 1895 to 1902.

YEAR.	Production of copper (pounds).	Average price per pound (cents).	DIVIDENDS.	
			Amount.	Average per pound (cents).
1895	380,614,060	10.73	$4,200,000	1.10
1896	460,060,160	10.98	5,575,000	1.21
1897	494,072,040	11.36	8,222,000	1.66
1898	526,512,000	12.05	12,647,000	2.40
1899	568,668,800	17.76	28,042,000	4.93
1900	602,848,640	16.65	30,071,000	4.99
1901	601,489,280	16.72	24,396,000	4.05
1902	639,083,392	12.16	11,034,242	1.73

Table 42, which follows, shows in detail the statistics of copper mines for 1902:

TABLE 42.—DETAILED SUMMARY: 1902.

	United States.	Arizona.	California.	Colorado.	Michigan.	Montana.	New Mexico.	Utah.	All other states.[1]
Number of mines	144	30	7	18	20	27	17	13	12
Number of operators	144	30	7	18	20	27	17	13	12
Character of ownership.									
Individual	19	1	2	1	....	5	8	1	1
Firm	23	8	....	4	....	8	2	1	....
Incorporated company	100	21	4	13	20	14	6	11	11
Other form	2	....	1	....	....	....	1	....	....
Salaried officials, clerks, etc.:									
Total number	1,208	258	38	25	419	310	24	51	83
Total salaries	$1,768,456	$399,275	$48,033	$17,338	$598,076	$494,415	$32,120	$71,155	$108,044
General officers—									
Number	116	25	....	3	49	21	....	9	9
Salaries	$311,479	$52,556	....	$633	$148,729	$61,434	....	$16,517	$31,610
Superintendents, managers, surveyors, foremen, etc.—									
Number	400	87	19	14	123	91	14	17	35
Salaries	$655,475	$155,868	$27,644	$11,185	$185,561	$187,635	$21,500	$24,193	$41,889
Foremen below ground—									
Number	337	59	10	5	152	75	6	14	16
Salaries	$459,611	$101,063	$12,480	$4,500	$164,477	$135,335	$6,870	$17,665	$17,221
Clerks—									
Number	355	87	9	3	95	123	4	11	23
Salaries	$341,891	$89,788	$7,909	$1,020	$99,309	$110,011	$3,750	$12,780	$17,324
Wage-earners:									
Aggregate average number	26,007	3,797	496	115	13,987	6,388	164	487	673
Aggregate wages	$21,151,405	$3,497,528	$445,247	$106,961	$8,744,992	$7,339,773	$128,483	$439,612	$446,989
Above ground—									
Total average number	7,584	1,178	111	23	4,817	1,192	29	41	193
Total wages	$5,358,509	$1,072,028	$105,236	$22,368	$2,546,064	$1,410,431	$29,842	$40,934	$131,606
Engineers, firemen, and other mechanics—									
Average number	2,858	450	77	14	1,293	885	20	33	86
Wages	$2,792,418	$538,565	$78,068	$15,588	$939,284	$1,095,830	$24,412	$34,714	$65,957
Miners—									
Average number	53	11	....	....	19	....	2	....	21
Wages	$47,829	$11,241	....	....	$13,176	....	$1,200	....	$22,212
Boys under 16 years—									
Average number	68	47	....	....	5	....	....	....	16
Wages	$30,091	$25,720	....	....	$1,305	....	....	....	$3,066
All other wage-earners—									
Average number	4,605	670	34	9	3,500	307	7	8	70
Wages	$2,488,171	$496,502	$27,168	$6,780	$1,592,299	$314,601	$4,230	$6,220	$40,371

[1] Includes operators distributed as follows: Idaho, 1; Nevada, 1; North Carolina, 2; Oregon, 2; Tennessee, 2; Virginia, 1; Washington, 1; Wisconsin, 1; Wyoming, 1.

TABLE 42.—DETAILED SUMMARY: 1902—Continued.

	United States.	Arizona.	California.	Colorado.	Michigan.	Montana.	New Mexico.	Utah.	All other states.
Wage-earners—Continued									
Aggregate wages—Continued									
Below ground—									
Total average number	18,423	2,619	385	92	9,070	5,196	135	446	480
Total wages	$15,792,896	$2,425,300	$340,011	$86,613	$6,198,828	$5,929,342	$98,641	$398,678	$315,283
Miners—									
Average number	12,768	1,679	341	82	5,381	4,518	118	435	214
Wages	$11,900,164	$1,706,380	$299,177	$78,278	$4,018,260	$5,155,224	$88,223	$389,907	$164,115
Miners' helpers—									
Average number	1,257	700	18	7	392	4	14	9	113
Wages	$777,216	$471,150	$16,425	$6,400	$189,224	$3,900	$7,528	$7,402	$75,281
Boys under 16 years—									
Average number	35	3			32				
Wages	$13,800	$1,300			$12,500				
All other wage-earners—									
Average number	4,363	237	26	3	3,265	674	3	2	153
Wages	$3,101,722	$246,470	$24,409	$1,935	$1,978,844	$770,218	$2,890	$1,369	$75,887
Average number of wage-earners at specified daily rates of pay									
Engineers—									
$1.00 to $1.24	2				1				1
$1.25 to $1.49	29				23				6
$1.50 to $1.74	10				10				
$1.75 to $1.99	27				26				1
$2.00 to $2.24	74	1			69				4
$2.25 to $2.49	43				43				
$2.50 to $2.74	35	1	2		32				
$2.75 to $2.99	62		1		55				6
$3.00 to $3.24	21	1	7	2	1		2	6	2
$3.25 to $3.49	8		2	1				5	
$3.50 to $3.74	22	10	3	1			7	1	
$3.75 to $3.99	10	10							
$4.00 to $4.24	167	37		3		121		2	4
$4.25 and over	39	17				20	2		
Firemen—									
$1.00 to $1.24	1								1
$1.25 to $1.49	6				1				5
$1.50 to $1.74	10				9				1
$1.75 to $1.99	78				76				2
$2.00 to $2.24	129				129				
$2.25 to $2.49	1				1				
$2.50 to $2.74	99	7	3		87			2	
$2.75 to $2.99	8	8							
$3.00 to $3.24	20	6	2			8	1	3	
$3.25 to $3.49	1			1					
$3.50 to $3.74	134	20				108	1	1	4
$3.75 to $3.99	2	2							
$4.00 to $4.24	2					2			
Machinists, blacksmiths, carpenters, and other mechanics—									
$1.00 to $1.24	3				2				1
$1.25 to $1.49	10				1				9
$1.50 to $1.74	32				30				2
$1.75 to $1.99	90				82				8
$2.00 to $2.24	233	9			213	2			9
$2.25 to $2.49	137	8	8		120				1
$2.50 to $2.74	260	32	5		214	9			
$2.75 to $2.99	58		7		48		1		2
$3.00 to $3.24	173	76	28	1	11	50	1	5	1
$3.25 to $3.49	49	37	1	1	5			2	3
$3.50 to $3.74	227	53	14	4	1	149	2	1	3
$3.75 to $3.99	24	17			4	3			
$4.00 to $4.24	273	89	1		2	170	2	2	7
$4.25 to $4.49	290	15			4	270	1		
Miners—									
$0.75 to $0.99	24								24
$1.00 to $1.24	1								1
$1.25 to $1.49	61	14							47
$1.50 to $1.74	36	7					9		20
$1.75 to $1.99	137	98					24		15
$2.00 to $2.24	2,076	35	67		1,967		1		6
$2.25 to $2.49	1,386	721	2		631		32		
$2.50 to $2.74	1,679	103	74	9	1,287		18	172	16
$2.75 to $2.99	368	53	115	4				191	5
$3.00 to $3.24	1,514	96	79	15	1,214		19	61	1
$3.25 to $3.49	7							4	3
$3.50 to $3.74	5,552	956	4	25		4,471	2		94
$3.75 to $3.99	1	1							
$4.00 to $4.24	40	5				35			
$4.25 and over	13	1				12			
Miners' helpers—									
$0.50 to $0.74	2								2
$1.00 to $1.24	110				110				
$1.25 to $1.49	88				64				24
$1.50 to $1.74	77				32		6		39
$1.75 to $1.99	497	482					5		10
$2.00 to $2.24	336	149			186				1
$2.25 to $2.49	20	18							2
$2.50 to $2.74	30		18				3	9	
$2.75 to $2.99	10								10
$3.00 to $3.24	18	7		7		4			
$3.50 to $3.74	38	14							24
Timbermen and track layers—									
$1.00 to $1.24	6				5				1
$1.50 to $1.74	14				9				5
$1.75 to $1.99	35				35				
$2.00 to $2.24	369				369				
$2.25 to $2.49	15				15				
$2.50 to $2.74	32		1		30			1	
$2.75 to $2.99	3		3						
$3.00 to $3.24	28	6	18	2	1			1	
$3.25 to $3.49	21	17	4						
$3.50 to $3.74	207	1				185	2		19
$3.75 to $3.99	17	15				2			
$4.00 to $4.24	26					26			

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[1] Includes timbermen and track layers.

TABLE 42.—DETAILED SUMMARY: 1902—Continued.

	United States.	Arizona.	California.	Colorado.	Michigan.	Montana.	New Mexico.	Utah.	All other states.
Average number of wage-earners at specified daily rates of pay—Continued.									
Boys under 16 years—									
$0.50 to $0.74	12								12
$0.75 to $0.99	8				4				4
$1.00 to $1.24	20	18			2				
$1.25 to $1.49	34	3			31				
$1.50 to $1.74	7	7							
$2.00 to $2.24	12	12							
$2.25 to $2.49	10	10							
All other wage-earners—									
$0.50 to $0.74	14				1				13
$0.75 to $0.99	17				4				13
$1.00 to $1.24	1,958				1,942				16
$1.25 to $1.49	137	7			74				56
$1.50 to $1.74	661	33		3	562				63
$1.75 to $1.99	1,530				1,529				1
$2.00 to $2.24	1,928	140	5		1,752	10	8		13
$2.25 to $2.49	458	207	9		228	9		5	
$2.50 to $2.74	150	64	11	3	43	24		2	3
$2.75 to $2.99	152	91	2		38			1	20
$3.00 to $3.24	327	142	6	4	18	157			
$3.25 to $3.49	45	33			2	10			
$3.50 to $3.74	559	123	1		1	434			
$4.00 to $4.24	97	30			9	58			
$4.25 and over	72	5			1	66			
Average number of wage-earners employed during each month:									
Men 16 years and over—									
January	24,885	3,534	384	117	13,839	5,603	111	555	742
February	24,658	3,519	345	112	13,257	6,102	121	514	688
March	25,602	3,709	387	124	13,679	6,363	141	498	701
April	26,088	3,686	482	129	14,118	6,304	160	503	706
May	27,073	3,941	543	124	14,512	6,567	146	513	727
June	26,466	3,937	585	117	13,952	6,538	173	513	651
July	26,938	3,854	635	118	14,249	6,656	147	528	651
August	25,908	3,967	664	117	13,760	6,168	182	493	657
September	25,698	3,714	679	113	13,660	6,317	161	487	567
October	26,273	3,742	611	115	13,973	6,585	212	430	605
November	25,720	3,665	434	97	13,490	6,838	212	406	578
December	25,639	3,796	223	97	13,711	6,615	202	404	591
Boys under 16 years—									
January	111	50			44				17
February	110	50			43				17
March	113	50			45				18
April	113	50			47				16
May	110	50			43				17
June	106	50			39				17
July	112	51			44				17
August	92	48			27				17
September	92	51			27				14
October	93	50			29				14
November	91	50			27				14
December	93	50			29				14
Contract work:									
Amount paid	$188,768	$122,337		$965	$11,725	$40,975	$10,266		
Number of employees	195	121		3	9	28	31		
Miscellaneous expenses:									
Total	$1,397,465	$256,753	$15,367	$4,608	$473,501	$456,108	$26,858	$71,448	$92,822
Royalties and rent of mine and mining plant	$130,215	$7,679	$1,200	$360	$2,842	$85,409	$12,123	$12,166	$8,436
Rent of offices, taxes, insurance, interest, and other sundries	$1,267,250	$249,074	$14,167	$4,248	$470,659	$370,699	$14,735	$59,282	$84,386
Cost of supplies and materials	$11,083,175	$2,135,676	$211,163	$38,221	$4,688,419	$3,649,127	$49,408	$166,226	$144,935
Value of product	$51,178,036	$8,279,224	$1,599,663	$71,411	$18,247,207	$20,563,353	$271,270	$1,459,192	$686,716
Power:									
Total horsepower	198,507	5,637	1,018	442	137,772	49,090	849	754	2,945
Owned—									
Engines—									
Steam—									
Number	792	56	12	7	439	218	15	13	32
Horsepower	189,426	4,808	408	275	137,522	43,057	846	405	2,105
Gas or gasoline—									
Number	35	24	2	2		3	1	3	
Horsepower	1,184	804	50	42		196	3	89	
Water wheels—									
Number	8		1	1		1		1	4
Horsepower	326		5	75		1		50	195
Other power—									
Number	34	1	2	1	3	20		2	5
Horsepower	5,235	25	125	50	250	4,030		110	645
Rented—									
Electric, horsepower	2,336		430			1,806		100	
Electric motors owned—									
Number	50	8	10	1	[illegible]	18		1	2
Horsepower	2,312	405	430	7	101	1,189		100	80
Supplied to other establishments, horsepower	87					87			

GOLD AND SILVER

GOLD AND SILVER.

By Isaac A. Hourwich, Ph. D.

Gold and silver mines as treated in this chapter embrace (1) gold washings, commonly known as placers; (2) deep mines, which yield gold and silver bearing ore; and (3) ore dressing and reduction works, commonly known as mills, and operated either in connection with mines or independently. Smelters were classified at the Twelfth Census as manufacturing establishments, and were therefore excluded from the census of mines and quarries.

The precious metals being frequently associated in the ore with base metals, a proper classification of mines by the character of metals produced is attended with certain difficulties and must perforce appear artificial. Thus, from a mineralogical or metallurgical point of view, an ore assaying 50 pounds of copper to the short ton and only 1 ounce of gold is a copper ore, whereas from a commercial standpoint it is a gold ore, since the value of the 1 ounce of gold is about three times the value of the copper contained in the ore. The criterion must be determined by the object of the classification. The object of an industrial census being primarily the study of economic conditions, the classification of industries must be based upon an economic test.

The product of a mine is accordingly defined here as a gold and silver ore whenever the precious metals constitute the principal elements of its commercial value. The statistics relative to the mining of copper ores carrying small values in gold and silver are presented, together with those for other copper ores. Argentiferous iron ores, valued chiefly as fluxing material, though carrying small quantities of silver, are classed with iron ores.

This rule, like any other, is not without exceptions. The value of argentiferous lead ores follows the fluctuations in the market prices of silver and lead. The price of silver in 1902 was the lowest in many years. As a result, some mines, whose product at the prices ruling in 1901 was regarded as silver ore, realized in 1902 less for the silver than for the lead contents of their ore. Many more mines, which at the previous censuses were classed as silver mines, would now have to be considered lead mines, if judged by the relative values of the silver and lead contents of their ores. Such a classification would obviously be purely accidental and would destroy the value of all comparisons with the results of previous censuses. It was, therefore, deemed necessary to include all argentiferous lead mines among gold and silver mines.

There was, furthermore, a very numerous class of mines whose operations in 1902 were confined to development work. Any classification of such mines by the character of the ore in sight in advance of actual production is of necessity arbitrary. Though the work may at present be pursued with the prospect of finding gold and silver in paying quantities, many of these mines, in the light of past experience, will develop into copper, iron, or zinc mines. Yet the commercial nature of the investment impresses all such ventures with the character of gold and silver mines.

Census statistics of the gold and silver industry from 1860 to 1902 are summarized in the following table:

TABLE 1.—COMPARATIVE SUMMARY: 1860 TO 1902.

	1902					1889	1880[1]	1870			1860
	Producing mines.			Development work without production.	All mines.			Total	Placer.	Deep.	
	Total.	Placer.	Deep.								
Number of mines	2,992	975	2,017	3,252	6,244	4,738	693	(2)	(2)	(2)	(2)
Number of operators	2,992	975	2,017	3,252	6,244	(2)	(2)	[3]2,377	1,994	383	[3]7,202
Salaried officials, clerks, etc.:											
Number	3,480	275	3,205	2,284	5,764	873	732	(2)	(2)	(2)	(2)
Salaries	$5,076,773	$324,418	$4,752,355	$2,335,470	$7,412,243	$1,347,373	(2)	(2)	(2)	(2)	(2)
Wage-earners:											
Average number	36,142	2,321	33,821	11,763	47,905	[4]50,434	18,415	16,608	10,141	6,467	11,316
Wages	$36,077,492	$1,818,758	$34,258,734	$11,580,684	$47,658,176	$40,412,022	$12,261,353	$8,796,525	$3,378,579	$5,417,946	$23,661,620
Contract work	$826,090	$19,953	$806,137	$1,342,771	$2,168,861	$1,421,301	(2)	(2)	(2)	(2)	(2)
Miscellaneous expenses	$5,357,529	$279,485	$5,078,044	$1,017,356	$6,371,885	$8,152,701	(2)	(2)	(2)	(2)	(2)
Cost of supplies and materials	$16,699,768	$790,986	$15,908,782	$5,075,077	$21,774,845	$13,817,739	$4,681,268	$4,064,333	$1,858,334	$2,205,999	$16,561,786
Value of product at mine:											
Total	$82,482,052	[5]$5,327,726	$77,154,326	....	$82,482,052	(2)	[6]$74,127,177	$26,452,652	$9,775,144	$16,677,508	$17,163,170
Deep	$77,154,326	....	$77,154,326	....	$77,154,326	(2)	[6]$62,030,745	$16,677,508	....	$16,677,508	(2)
Placer	$5,327,726	$5,327,726	....	....	$5,327,726	(2)	$12,096,432	$9,775,144	$9,775,144	....	(2)

[1] All statistics, except for product, for deep mines only.

[2] Not reported.

[3] Establishments.

[4] Includes 2,937 salaried employees whose salaries are included in amount paid wage-earners and are not separable therefrom.

[5] Includes an estimated production of $1,138,181 for a number of small mines for which no reports were received directly from operators.

[6] The value of the copper and lead by-product for Utah, Colorado, and Montana, $4,689,178, is added to the value of the precious metals. The product included 31,797,474 ounces of silver, which were reported at coining value. For the purpose of comparison the value has been reduced to commercial value, at the rate of $1.134 per ounce fine, which was the average for the year 1879 and 1880. The total value reported at the Tenth Census was $79,179,798.

Few reliable comparisons can be based upon the figures summarized in Table 1, as the method of collecting and presenting the data varied from census to census. The statistics for 1889 include those for mines at which only development work was done. This is probably true of the previous Census reports. The totals for 1902 were therefore summarized to show also the statistics of mines reporting development work only.

Development work.—In Table 1 is shown the extent of development work done in mines from which no production was reported. This kind of work was generally prosecuted to some extent in producing mines as well, but was always reported as a part of the ordinary mining expenses. In many cases the account was kept separately; where it was not, no separate report could be made, for the operators were unable to estimate the cost with any degree of accuracy. The total amount expended by regular producers, as far as reported, was $4,683,929. There were, moreover, a number of mines the expenditures for which largely exceeded the receipts. In some instances this may have been due to a poor grade of ore; in others to unfavorable conditions which made mining unprofitable. In most cases, however, an examination of the mine reports disclosed no difference in the grade of ore or the charges for treatment and freight as compared with other producing mines of the same district; the excess of expenditures over returns was therefore presumably due to outlays for development. All such reports were classified separately. This classification was not extended, however, to mines combined with mills, for in such cases heavy expenditures might have been incurred for mill equipment and construction work other than development. A summary of such mines, distinguished as "developing and producing," is presented in the following table, in parallel columns with data relating to regular producers, designated as "productive:"

TABLE 2.—*Comparative summary of productive and of developing and producing mines without mill connection in the United States: 1902.*

	DEEP.		PLACER.	
	Productive.	Developing and producing.	Productive.	Developing and producing.
Number of mines	700	575	818	157
Salaried officials, clerks, etc.:				
Number	653	545	190	85
Salaries	$988,181	$622,277	$229,124	$95,294
Wage earners:				
Average number	6,634	5,851	1,715	606
Wages	$7,005,021	$3,774,122	$1,347,147	$471,611
Contract work	$198,432	$188,685	$10,422	$9,531
Work on share of product	$1,044,140	$195,239	$76,749	....
Miscellaneous expenses	$1,453,719	$468,669	$234,327	$45,158
Cost of supplies and materials	$2,760,323	$1,715,261	$588,254	$202,732
Ore sold and treated, short tons	1,326,757	228,614	....	....
Value of bullion contents:				
Gold	$18,444,330	$2,753,241	....	....
Silver	$9,014,601	$1,125,930	....	....
Other metals	$2,420,183	$468,576	....	....
Total gross value	$29,879,114	$4,347,747	....	....
Average per ton	$23	$19	....	....
Treatment charges and freight	$9,371,678	$1,679,111	....	....
Average per ton	$7	$7	....	....
Value of product at mine	$20,507,436	$2,668,636	$5,096,909	$230,817

Number of mines and operators.—These terms, whose meaning is perfectly plain in ordinary language, require a further definition when applied in a statistical sense to gold and silver mining.

There are few mines which represent one original location; most of the mining properties represent "groups" of mines, which were at some time past operated as independent undertakings, but have since been united, by purchase, lease, or otherwise, under one management. The identity of some of these mines may still be preserved; in most cases, however, their accounts are not segregated, or are only imperfectly segregated, on the books of the present owners. Thus some operators will make a separate report for each mine, while others will make one report for the group, though the difference between the properties may be in the system of bookkeeping rather than in mining conditions.

Where a mine was operated by a lessee a report was required from him. But in some mining districts it is customary to apportion the mine, in small allotments or "blocks," among a number of miners working on a royalty and designated as "lessees." The shifting character of this class of "lessees" precluded a complete canvass of their operations; in all such cases the owner of the mining property was required to make one report covering all his lessees.

In placer mining there are numerous prospectors and gold seekers moving from place to place who can not be reached by a census of mines. These miners are not included in the number of operators, but their production was ascertained from other reliable sources and is included.

A number of mines changed hands in the course of the year, and separate reports were received from each of the parties by whom the mine was successively operated. While the location and equipment of the mine remained the same, yet the character of ownership, capitalization, method of treatment of the ore, etc., in some cases had undergone a change; a combination of heterogeneous reports, made by different operators, into one, for the mines, was impracticable. Mills operated in connection with mines were by some operators reported separately and by others were included in the mine report.

In order to meet all these varying conditions it was deemed advisable to accept every individual report as a unit of enumeration, except that reduction works when connected with mines were in all cases counted as a part of the mine equipment. The number of mines and the number of operators as given in the tables are, therefore, identical. The total number of active mines, as here defined, was 2,992.

There were, furthermore, 3,252 mines which were operated in 1902 but reported no production, the work being confined to the development of the mines. This does not include mining prospects upon which "assessment work" was done, i. e., the quantity of labor required by law as a condition for holding title to the mining claim. The scope of the census of mines and quarries did not comprise a canvass of mining prospects, but a number of mining properties locally reported as active or in the development stage proved upon inquiry to be mere prospects. The number of claims which were thus reported and the number of their owners are shown in the following table, by states and territories, arranged according to the number of claims reported:

TABLE 3.—*Mining prospects upon which assessment work was done, by states and territories: 1902.*

STATE OR TERRITORY.	Number of owners.	Number of claims.
United States	5,135	5,511
California	1,219	1,322
Washington	943	995
Colorado	618	633
Oregon	422	502
Idaho	460	476
Nevada	419	439
New Mexico	403	403
Arizona	384	389
Utah	194	213
South Dakota	31	98
Wyoming	20	20
Montana	17	17
Arkansas	2	2
Alabama	1	1
North Carolina	1	1

As shown by Table 3, the attention of the prospectors was turned mainly to California, Washington, and Colorado, over one-half of the claims being located in those 3 states. The lowest rank among the Western states was held by Montana, which reported only 17 prospectors. Prospecting in the Southern states was exceptional. The total number of claims reported exceeded but little the number of owners. There were in all 43 owners reporting more than one claim each, and the total number of claims held by them was 419; the highest number of claims held by one owner was 32, and was reported from Oregon. The following table shows the distribution of owners by the number of claims held:

TABLE 4.—*Distribution of mining prospectors by number of claims held: 1902.*

NUMBER OF CLAIMS HELD BY EACH PROSPECTOR.	Number of owners.	Number of claims.
Total	5,135	5,511
1	5,092	5,092
2	2	4
3	4	12
4	3	12
5	3	15
6	2	12
7	6	42
8	7	56
9	4	36
10	2	20
11	1	11
13	1	13
14	1	14
16	2	32
20	1	20
28	1	28
30	2	60
32	1	32

The total number of mines reported as idle was 3,957. This number embraces only mines which had been previously reputed as active, and the owners of which were therefore either communicated with by mail or visited by special agents. There were doubtless many more mines which had at some time been operated, but were idle in 1902.

Character of ownership.—The majority of gold and silver mining enterprises in 1902 did not have an incorporated form of organization. A distinction is to be noted in this respect between deep mines and those in the development stage on the one hand and placers on the other hand: while about one-half of the former were operated by incorporated companies, the owners of only about one-sixth of the latter were incorporated. Another noteworthy fact is that the majority of incorporated companies were engaged exclusively in development work, whereas the majority of firms and individuals operated producing mines. It would seem, therefore, that the corporate form of ownership is more favorable to the development of modern mines. The following table presents the classification of all mines by character of ownership:

TABLE 5.—*All mines, classified by character of ownership: 1902.*

	Total.	Incorporated company.	Firm.	Individual.	Other form.
All mines	6,244	2,774	1,772	1,641	57
Producing mines:					
Total	2,992	1,079	923	958	32
Deep	2,017	923	575	501	18
Placer	975	156	348	457	14
Development work	3,252	1,695	849	683	25

The mines classed as "other form" included cooperative associations, mines held in joint ownership and by estates, etc.

The corporate form of ownership was especially prevalent among producing mines in Arizona, Colorado, and Utah; the owners of more than one-half of all mines in the first two and of four-fifths of those in the last-named state being incorporated companies. Among mines reporting development work only, the corporate form predominated in Arizona, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming.

The share contributed by each type of organization to the production is shown in Table 6.

TABLE 6.—*Producing mines, classified by character of ownership and value of product: 1902.*

CHARACTER OF OWNERSHIP.	Number of operators.	VALUE OF PRODUCT AT MINES.		
		Total.	Per cent.	Average per mine.
All mines	2,992	$82,482,052	100.0	[1] $27,021
Incorporated company	1,079	68,327,754	82.8	63,325
Firm	923	8,398,221	10.2	9,099
Individual	958	3,890,304	4.7	4,061
Other form	32	231,938	0.3	7,248
Not classified		1,633,835	2.0	
Deep mines	2,017	77,154,326	100.0	[1] 38,006
Incorporated company	924	65,831,994	85.3	71,247
Firm	576	7,577,430	9.8	13,155
Individual	499	3,108,535	4.0	6,230
Other form	18	140,713	0.2	7,817
Not classified		495,654	0.7	
Placer mines	975	5,327,726	100.0	[1] 4,297
Incorporated company	155	2,495,760	46.9	16,102
Firm	347	820,791	15.4	2,365
Individual	459	781,769	14.7	1,703
Other form	14	91,225	1.7	6,516
Not classified		1,138,181	21.3	

[1] The "not classified" product was excluded in obtaining this average.

The preceding table shows that the corporate form of ownership, though adopted by only a little over one-third of all active operators, figured in more than four-fifths of the total output of the mines and showed the largest output per mine. Both firms and individuals belonged to the small type of producers. Other forms of organization represented but three-tenths of 1 per cent of the total output. The corporate form of ownership played a more important part in deep than in placer mining, the ownership of about one-half of all deep mines, contributing over five-sixths of the product, being that of incorporated companies, whereas the number of incorporated owners of placer mines was less than one-sixth of all placer mines, and their product was but about one-half of the total for all mines.

The following table is a summary for mines owned by incorporated and by unincorporated operators:

TABLE 7.—SUMMARY FOR ALL MINES, BY CHARACTER OF OWNERSHIP: 1902.

	ALL MINES.			DEEP MINES.			PLACER MINES.		
	Total.	Incorporated.	Unincorporated.	Total.	Incorporated.	Unincorporated.	Total.	Incorporated.	Unincorporated.
Number of operators	2,992	1,079	1,913	2,017	924	1,093	975	155	820
Salaried employees:									
General officers—									
Number	437	437		408	408		29	29	
Salaries	$810,555	$810,555		$772,968	$772,968		$37,587	$37,587	
Other salaried employees—									
Number	3,043	2,527	516	2,797	2,326	471	246	201	45
Salaries	$4,266,218	$3,634,263	$631,955	$3,979,387	$3,386,286	$593,101	$286,831	$247,977	$38,854
Wages	$36,077,492	$30,053,790	$6,023,702	$34,254,514	$28,927,165	$5,327,349	$1,822,978	$1,126,625	$696,353
Contract work	$626,090	$521,921	$104,169	$606,137	$511,436	$94,701	$19,953	$10,485	$9,468
Work on share of product	$1,621,878	$1,164,955	$456,923	$1,545,129	$1,164,315	$380,814	$76,749	$640	$76,109
Miscellaneous expenses	$5,357,529	$4,419,537	$937,992	$5,078,044	$4,223,025	$855,019	$279,485	$196,512	$82,973
Cost of supplies and materials	$16,699,768	$14,677,977	$2,021,791	$15,908,402	$14,081,894	$1,826,508	$791,366	$596,083	$195,283
Ore sold and treated, short tons	9,542,864	8,464,023	1,078,841	9,542,864	8,464,023	1,078,841			
Value of bullion contents:									
Gold	$62,324,093	$54,023,002	$8,301,091	$58,122,187	$51,520,030	$6,602,157	$4,201,906	$2,502,972	$1,698,934
Silver	$21,318,028	$18,563,353	$2,754,675	$21,315,793	$18,561,793	$2,754,000	$2,235	$1,560	$675
Lead	$12,259,105	$10,199,325	$2,059,780	$12,259,105	$10,199,325	$2,059,780			
Other metals	$1,558,009	$1,300,649	$257,360	$1,557,155	$1,300,185	$256,970	$854	$464	$390
Total gross value	$97,459,235	$84,086,329	$13,372,906	$93,254,240	$81,581,333	$11,672,907	$4,204,995	$2,504,996	$1,699,999
Average value per ton				$10	$10	$11			
Value of product at mine[1]	$80,848,217	$68,327,754	$12,520,463	$76,658,672	$65,831,994	$10,826,678	$4,189,545	$2,495,760	$1,693,785
Average per mine	$27,021	$63,325	$6,545	$38,006	$71,247	$9,905	$4,297	$16,102	$2,066

[1] In addition to this, $1,633,835 represents the product of mines for which the number of operators and character of ownership was not reported, $495,654 being the value produced by deep mines and $1,138,181 that by placers.

As appears from Table 7, there were approximately 3 salaried officials, clerks, etc., to an average mine of incorporated ownership, whereas only 1 mine in 4 of those owned by unincorporated operators had even 1 salaried employee; evidently at the mines of unincorporated owners the work usually done by salaried employees was performed by the operators themselves. It is worthy of note that notwithstanding the large number of mines under corporate ownership, the gold and silver mining industry remained under local control. The location of the general office of the mine may be taken as a test. The following statement shows the number of mines with general offices in the principal business or mining centers and those whose offices were located in other cities or towns, or at the mine:

Location of general offices of mines by cities: 1902.

LOCATION OF GENERAL OFFICE.	All mines.	Producing	Development work without production.
Total	6,244	2,992	3,252
San Francisco	212	133	79
Salt Lake City	249	77	172
Denver	278	136	142
New York	136	53	83
Boston	73	34	39
All others	5,296	2,559	2,737

The number of companies with general offices in large business or mining centers was considerably short of the total number of incorporated companies. Moreover, those with offices in San Francisco, Salt Lake City, or Denver were likewise mostly local concerns whose mines were situated within the same state. This was equally true of producing and of developing mines, which fact appears from the following statement:

General offices, whether within or without the state where the mine is situated: 1902.

LOCATION OF GENERAL OFFICE.	LOCATION OF MINE.	
	Within the state.	Without the state.
San Francisco	159	53
Salt Lake City	192	57
Denver	262	16
Total	613	126
Producing	328	65
Developing	285	61

The few producing mines with eastern offices in New York and Boston had but a very small part in the gold and silver mining industry in 1902. Their aggregate product amounted to $4,122,206—5 per cent of the total for the United States—and the average product per company was only $49,000.

Capital stock of incorporated companies.—The capitalization of all incorporated gold and silver mining companies for 1902 is shown in Tables 8 and 9; the former relating to producing mines, the latter to such as reported development work only for the year 1902.

TABLE 8.—CAPITALIZATION OF INCORPORATED COMPANIES OPERATING PRODUCING MINES: 1902.

	United States.	Alabama.	Arizona.	Arkansas.	California.	Colorado.	Georgia.	Idaho.	Montana.
Number of incorporated companies	1,079	2	68	1	241	389	17	75	63
Capital stock and bonds issued	$1,024,970,643	$1,512,000	$38,874,129	$1,577,000	$160,121,081	$397,621,733	$19,082,000	$65,682,257	$70,328,140
Capital stock:									
Total authorized—									
Number of shares	773,862,231	602,000	38,951,000	20,000	91,923,578	382,343,293	17,867,500	36,962,340	29,351,580
Par value	$1,213,420,117	$3,002,000	$50,340,000	$2,000,000	$292,760,300	$440,035,417	$22,500,000	$80,404,200	$78,450,000
Total issued—									
Number of shares	611,045,694	394,000	27,501,129	15,770	71,964,616	325,997,522	15,216,520	28,616,387	21,615,899
Par value	$1,017,011,793	$1,512,000	$37,661,129	$1,577,000	$159,476,031	$392,887,833	$18,952,000	$65,348,357	$69,660,140
Dividends paid	$10,454,744	......	$404,550	......	$1,199,399	$3,689,444	......	$880,271	$248,093
Common—									
Authorized—									
Number of shares	766,744,974	602,000	36,931,000	20,000	91,333,578	380,454,435	17,867,500	36,171,940	29,293,580
Par value	$1,194,317,427	$3,002,000	$48,320,000	$2,000,000	$292,070,300	$432,642,717	$22,500,000	$76,904,200	$77,250,000
Issued—									
Number of shares	605,187,956	394,000	25,501,129	15,770	71,674,616	324,265,489	15,216,520	28,340,312	21,560,385
Par value	$1,002,055,596	$1,512,000	$35,661,129	$1,577,000	$159,186,031	$386,171,633	$18,952,000	$63,499,857	$68,609,040
Dividends paid	$10,124,711	......	$404,550	......	$1,199,399	$3,425,051	......	$880,271	$248,093
Preferred—									
Authorized—									
Number of shares	7,117,257	......	2,020,000	......	590,000	1,888,858	......	790,400	58,000
Par value	$19,102,690	......	$2,020,000	......	$690,000	$7,392,700	......	$3,500,000	$1,200,000
Issued—									
Number of shares	5,857,738	......	2,000,000	......	290,000	1,732,033	......	276,075	55,514
Par value	$14,966,197	......	$2,000,000	......	$290,000	$6,716,200	......	$1,848,500	$1,051,100
Dividends paid	$330,033	......	......	......	......	$264,393	......	......	......
Bonds:									
Authorized—									
Number	445,578	......	1,965	......	2,735	113,900	175,000	150,498	1,190
Par value	$9,839,200	......	$1,435,000	......	$765,000	$5,365,000	$175,000	$834,200	$890,000
Issued—									
Number	296,147	......	1,408	......	1,491	11,642	130,000	150,490	818
Par value	$7,958,850	......	$1,213,000	......	$645,050	$4,733,900	$130,000	$333,900	$668,000
Interest paid	$409,392	......	$78,710	......	$42,862	$211,130	$6,500	$14,000	$40,200
Assessments levied	$21,200,119	......	$169,950	......	$3,980,454	$186,015	$5,000	$54,324	$1,472

	Nevada.	New Mexico.	North Carolina.	Oregon.	South Carolina.	South Dakota.	Texas.	Utah.	Washington.	Wyoming.
Number of incorporated companies	41	39	6	18	2	23	1	67	15	3
Capital stock and bonds issued	$49,664,296	$24,472,731	$4,900,000	$25,118,821	$750,000	$54,511,396	......	$85,251,659	$20,487,100	$5,016,000
Capital stock:										
Total authorized—										
Number of shares	20,006,300	36,025,200	3,215,000	31,790,440	550,000	28,017,000	150,000	21,162,000	23,700,000	7,625,000
Par value	$55,492,400	$44,400,000	$9,250,000	$38,955,800	$550,000	$64,150,000	$150,000	$89,265,000	$23,950,000	$7,625,000
Total issued—										
Number of shares	15,235,801	17,337,531	2,156,000	18,299,761	550,000	20,846,969	......	19,668,680	20,683,110	5,016,000
Par value	$49,664,296	$24,437,731	$4,900,000	$25,118,821	$550,000	$54,511,396	......	$85,251,659	$20,487,100	$5,016,000
Dividends paid	$77,602	$69,650	......	61,669	......	$262,891	......	$3,661,175	......	......
Common—										
Authorized—										
Number of shares	19,556,300	36,005,200	3,215,000	31,790,440	400,000	27,717,000	150,000	21,162,000	23,450,001	7,625,000
Par value	$55,042,400	$44,200,000	$9,250,000	$38,955,800	$400,000	$63,250,000	$150,000	$89,265,000	$21,450,010	$7,625,000
Issued—										
Number of shares	14,935,801	17,317,531	2,156,000	18,299,761	400,000	19,964,862		19,668,680	20,551,008	5,016,000
Par value	$49,364,296	$24,237,731	$4,900,000	$25,118,821	$400,000	$53,629,289	......	$85,251,659	$18,966,010	$5,016,000
Dividends paid	$29,602	$69,650	......	$61,669	......	$245,251	......	$3,661,175	......	......
Preferred—										
Authorized—										
Number of shares	450,000	20,000	......	......	150,000	300,000	......	......	249,999	......
Par value	$450,000	$200,000	......	......	$150,000	$900,000	......	......	$2,499,990	......
Issued—										
Number of shares	300,000	20,000	......	......	150,000	882,107	......	......	132,102	......
Par value	$300,000	$200,000	......	......	$150,000	$882,107	......	......	$1,521,090	......
Dividends paid	$48,000	......	......	......	......	$17,640	......	......	......	......
Bonds:										
Authorized—										
Number	......	95	......	......	200	......	......	......	......	......
Par value	......	$35,000	......	......	$200,000	......	......	......	......	......
Issued—										
Number	......	95	......	......	200	......	......	......	......	......
Par value	......	$35,000	......	......	$200,000	......	......	......	......	......
Interest paid	......	......	......	......	$16,000	......	......	......	......	......
Assessments levied	$15,361,010	$98,000	......	$187,022	$21,000	$537,257		$561,635	$190,000	......

TABLE 9.—CAPITALIZATION OF INCORPORATED COMPANIES REPORTING DEVELOPMENT WORK WITHOUT PRODUCTION: 1902.

	United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.	Idaho.	Maryland.	Montana.	Nevada.
Number of incorporated companies	1,695	1	207	116	183	2	158	1	59	61
Capital stock and bonds issued	$1,173,300,352	$2,000	$195,411,287	$89,274,263	$277,567,162	$100,000	$71,015,357	$1,000,000	$75,998,516	$39,471,081
Capital stock:										
Total authorized—										
Number of shares	1,728,938,161	10	290,138,390	64,817,786	412,718,390	5,200,000	118,929,000	40,000	95,119,000	36,775,460
Par value	$1,908,351,126	$2,000	$354,340,000	$122,763,125	$406,520,820	$6,000,000	$120,858,000	$1,000,000	$132,887,000	$54,956,080
Total issued—										
Number of shares	1,010,012,582	10	127,086,731	95,687,521	394,964,632	100,000	85,335,944	40,000	42,662,417	27,613,829
Par value	$1,171,138,461	$2,000	$193,504,907	$89,274,263	$277,467,162	$100,000	$70,912,846	$1,000,000	$75,998,516	$39,471,081
Dividends paid	$75,144			$60,000			$5,190			$954
Common—										
Authorized—										
Number of shares	1,713,435,071	10	288,258,390	64,702,786	406,797,390	5,180,000	117,066,500	40,000	95,119,000	36,259,460
Par value	$1,891,552,126	$2,000	$352,460,000	$121,613,125	$398,947,820	$5,900,000	$119,118,000	$1,000,000	$132,887,000	$53,381,080
Issued—										
Number of shares	1,001,916,256	10	126,392,394	95,672,521	391,470,436	100,000	84,283,444	40,000	42,662,417	27,270,236
Par value	$1,162,290,213	$2,000	$192,810,570	$89,124,263	$273,271,026	$100,000	$69,975,626	$1,000,000	$75,998,516	$38,995,726
Dividends paid	$69,000			$60,000						
Preferred—										
Authorized—										
Number of shares	15,503,090		1,880,000	115,000	5,921,000	20,000	1,862,500			516,000
Par value	$16,799,000		$1,880,000	$1,150,000	$7,573,000	$100,000	$1,740,000			$1,575,000
Issued—										
Number of shares	8,686,326		694,337	15,000	3,494,196		1,052,500			343,593
Par value	$8,848,248		$694,337	$150,000	$4,196,136		$937,220			$475,355
Dividends paid	$6,144						$5,190			$954
Bonds:										
Authorized—										
Number	5,810		3,000		1,000		760			
Par value	$3,340,040		$3,000,000		$100,000		$180,040			
Issued—										
Number	3,540		1,875		1,000		515			
Par value	$2,161,891		$1,906,380		$100,000		$102,511			
Interest paid	$56,570		$46,132		$8,000		$2,438			
Assessments levied	[illegible]		$40,000	$1,771,230			$195,925		$127,400	$27,666,812

	New Jersey.	New Mexico.	North Carolina.	Oregon.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.
Number of incorporated companies	1	73	10	100	80	188	1	106	65
Capital stock and bonds issued	$400,000	$44,691,863	$4,984,500	$125,990,915	$47,167,955	$73,754,408	$2,600,550	$91,329,650	$32,510,955
Capital stock:									
Total authorized—									
Number of shares	500,000	68,543,750	1,011,120	140,231,615	133,100,000	81,971,000	3,900,000	179,830,000	60,062,000
Par value	$500,000	$69,135,000	$17,112,000	$193,450,000	$137,770,000	$92,839,000	$5,400,000	$136,317,500	$57,480,000
Total issued—									
Number of shares	400,000	39,574,499	1,189,620	70,976,019	38,092,497	66,853,561	1,160,550	133,238,641	34,626,078
Par value	$400,000	$44,638,863	$4,984,500	$125,990,915	$47,167,955	$73,754,408	$2,600,550	$91,329,650	$32,510,955
Dividends paid				$9,000					
Common—									
Authorized—									
Number of shares	500,000	68,165,250	1,011,120	140,231,615	132,500,000	81,971,000	3,900,000	175,980,000	59,662,000
Par value	$500,000	$68,509,000	$17,112,000	$193,450,000	$137,170,000	$92,839,000	$5,400,000	$134,382,500	$57,280,000
Issued—									
Number of shares	400,000	39,265,799	1,189,620	70,976,019	37,562,497	66,853,561	1,160,550	131,190,641	34,426,078
Par value	$400,000	$44,181,663	$4,984,500	$125,990,915	$46,637,955	$73,754,408	$2,600,550	$90,021,650	$32,410,955
Dividends paid				$9,000					
Preferred—									
Authorized—									
Number of shares		378,500			600,000			3,850,000	400,000
Par value		$626,000			$600,000			$1,935,000	$200,000
Issued—									
Number of shares		308,700			530,000			2,048,000	200,000
Par value		$457,200			$530,000			$1,308,000	$100,000
Dividends paid									
Bonds:									
Authorized—									
Number		1,050							
Par value		$60,000							
Issued—									
Number		150							
Par value		$53,000							
Interest paid									
Assessments levied			$32,000	$54,750	$6,000	$1,678,926		$146,336	

A comparison of the results shown in Tables 8 and 9 shows that the amount of outstanding stock and bonds of the companies which reported only development work in 1902 was greater than that of the companies reporting production, viz, $1,173,300,352 for the former as compared with $1,024,970,643 for the latter. The share of placers in the total outstanding capitalization of producing mines amounted to $68,005,794, or 6.6 per cent, while that of deep mines was $956,964,849.

The division of stock into common and preferred is not customary with gold and silver mining companies. In 1902 there were 77 companies having preferred stock, the par value of that issued being $23,804,445. This was only 1 per cent of the total outstanding capitalization of producing mines.

Assessment companies, once a prominent feature in gold and silver mining, are less conspicuous to-day. There were, in 1902, 250 assessment companies, of which 99 operated producing and 151 nonproducing mines. The amount of assessments levied since organization by the former was $21,200,119, and by the latter $31,657,563, a total of $52,857,682, representing an addition of 2 per cent to the total outstanding capital stock and funded indebtedness. The greater part of this amount, $42,966,822, was reported from Nevada, where assessments are still among the favorite means of raising funds for investment in gold and silver mining.

The issue of bonds was little favored, the total amount issued on producing and developing mines being only $10,120,741. The following statement shows the distribution of incorporated companies by the class of stock authorized and issued:

Incorporated companies, grouped by class of stock: 1902.

CLASS OF STOCK	Number of incorporated companies.	AUTHORIZED			ISSUED.		
		Total.	Common.	Preferred.	Total.	Common.	Preferred.
Operating producing mines: Total	1,079	$1,213,420,117	$1,194,317,427	$19,102,690	$1,017,111,793	$1,002,155,596	$14,956,197
Both common and preferred	31	62,229,600	43,126,910	19,102,690	52,649,632	37,693,435	14,956,197
Common only	1,048	1,151,190,517	1,151,190,517	....	964,462,161	964,462,161	....
Reporting development work without production: Total	1,695	1,908,351,126	1,891,552,126	16,799,000	1,171,138,461	1,162,290,213	8,848,248
Both common and preferred	46	60,159,000	43,360,000	16,799,000	57,541,728	48,693,480	8,848,248
Common only	1,649	1,848,192,126	1,848,192,126	....	1,113,596,733	1,113,596,733	....

The following table shows the par value of the authorized capital stock and bonds of all gold and silver mining companies engaged in deep or placer mining, producing and nonproducing, by states and territories, for 1902 and 1880:

TABLE 10.—*Authorized capitalization of incorporated companies, producing and nonproducing mines, by states and territories: 1902 and 1880.*

STATE OR TERRITORY.	1902		1880	
	Number of incorporated companies.	Capital stock and bonds authorized—par value	Number of incorporated companies	Capital stock and bonds authorized—par value
United States	2,774	$3,134,300,483	468	$2,063,817,590
Alabama	3	8,000,000	....	....
Arizona	250	400,115,000	38	136,400,000
Arkansas	1	2,000,000	....	....
California	387	326,508,426	66	373,001,250
Colorado	822	851,641,237	136	328,902,500
Georgia	19	28,675,000	8	1,510,000
Idaho	233	291,776,440	13	6,115,000
Maine	....	....	11	6,400,000
Maryland	1	1,000,000	....	....
Montana	222	212,417,100	9	19,960,000
Nevada	105	110,115,100	78	750,685,000
New Hampshire	....	....	1	500,000
New Jersey	1	500,000	....	....
New Mexico	112	113,620,000	2	2,000,000
North Carolina	16	26,862,000	7	5,400,000
Oregon	148	232,105,800	2	5,000,000
South Carolina	2	750,000	....	....
South Dakota	103	201,920,000	21	115,500,000
Texas	1	150,000	....	....
Utah	255	182,044,000	12	136,501,000
Virginia	4	5,300,000	3	750,000
Washington	121	140,257,500	1	400,000
Wyoming	68	65,105,000	....	....
Placer mines not classified by states	....	....	56	27,115,000

There were in all 136 companies by which dividends were paid in 1902; of these 121 operated deep mines and 15 placer mines. The following statement shows the capitalization and dividends of all dividend paying companies and also the capitalization of the companies which paid no dividends in 1902.

The statement shows that the average par value per share of stock varied, ranging from a minimum of $1.47 for nondividend paying common stock to a maximum of $3.61 for dividend paying preferred. There was no material difference between the average par value of stock authorized and issued for dividend paying and nondividend paying companies, although the average for the former was somewhat higher than for the latter. Of the 136 companies which paid dividends in 1902, 4 paid them on preferred stock only. Their authorized capital stock was $3,925,000, of which $2,400,000 was common and $1,525,000 was preferred. The outstanding common stock amounted to $2,150,000 and the outstanding preferred to $1,457,632. The amount paid in dividends on preferred stock was $93,285. One company, with an authorized capital stock of $9,864,600, of which $5,918,800 was common and $3,945,800 was preferred, all being issued, paid in dividends $236,752 on common and $236,748 on preferred stock.

The average rate of dividends on common stock was 5.5 per cent and on preferred 6.4 per cent. One hundred and thirty-one other companies had only one class of stock upon which dividends were paid. There were 21 companies authorized to issue bonds of a total par value of $9,839,200; the bonds were issued of a par value of $7,958,850. The average value of bonds per share of stock authorized was $22.08 and per share issued, $26.88. The total amount of interest paid was $409,392, averaging 6 per cent. None of these 21 companies paid dividends on its stock.

Capitalization of dividend paying and nondividend paying companies with dividends and interest paid: 1902.

	AUTHORIZED.			ISSUED.			
	Number of shares or bonds.	Total par value.	Average per share or bond.	Number of shares or bonds.	Total par value.	Average per share or bond.	Dividends or interest paid.
Dividend paying companies:							
Total capitalization	119,629,807	$243,187,750	$2.03	94,717,950	$191,020,365	$2.01	$10,454,744
Common stock	118,065,349	237,716,950	2.01	93,220,860	185,616,933	1.99	10,124,711
Preferred stock	1,564,458	5,470,800	3.50	1,497,090	5,403,432	3.61	330,033
Nondividend paying companies:							
Total capitalization	654,678,402	980,171,567	1.50	516,623,891	833,950,278	1.61	409,392
Common stock	648,679,025	956,660,477	1.47	511,067,096	816,438,663	1.59	....
Preferred stock	5,552,799	13,621,890	2.45	4,360,648	9,552,765	2.19	....
Bonds	445,578	9,839,200	22.08	296,147	7,958,850	26.88	409,392

The following is a statement of dividends paid by incorporated companies in 1902 and 1884, compared with the production of the precious metals for the same years:

YEAR.	Number of mines.	Amount of dividends.	Gross value of the precious metals (commercial).
1902[1]	136	$10,454,744	$85,223,732
1884[2]	54	7,567,028	72,870,000

[1] Exclusive of Alaska.

[2] Report of the Director of the Mint on the Production of the Precious Metals in the United States, 1884, page 14.

A summary of dividend and nondividend paying companies is presented in Table 11. It must be borne in mind that the payment of dividends in a given year is not indicative of net profits earned during the same year, for dividends may be paid from the accumulated surplus of former years. Among the 136 companies which paid dividends were 15 whose expenditures, mostly for development work, during the year exceeded their receipts. The dividends declared by these companies aggregated $615,149, out of a total product valued at $1,059,617. It is obvious that these dividends had no relation to the earnings of the year. Likewise, the failure to declare a dividend does not necessarily show actual loss. Earnings may have been invested in development work, in new equipment of plants, in acquiring new property, etc. It is fair to assume, however, that generally the payment of dividends is a sign of successful operation. To facilitate comparisons, all incorporated companies are arranged under three heads: (1) Dividend paying—that is, companies that paid dividends during 1902; (2) nondividend paying companies owning productive mines; (3) developing and producing companies, meaning companies with which production was merely incidental to development work, expenditures being in excess of receipts.

TABLE 11.—SUMMARY FOR DIVIDEND PAYING AND NONDIVIDEND PAYING COMPANIES, BY CLASSES OF MINES: 1902.

	ALL MINES.				DEEP MINES.				PLACER MINES.			
	Total.	Dividend paying.	Nondividend paying.		Total.	Dividend paying.	Nondividend paying.		Total.	Dividend paying.	Nondividend paying.	
			Productive.	Developing and producing.			Productive.	Developing and producing.			Productive.	Developing and producing.
Number of operators	1,079	136	614	329	924	117	535	272	155	19	79	57
Salaries:												
General officers	$810,555	$241,747	$487,345	$81,463	$772,968	$225,312	$471,450	$76,206	$37,587	$16,435	$12,925	$8,227
Other salaried **employees**	$3,634,263	$1,340,419	$1,800,118	$493,826	$3,386,286	$1,301,095	$1,674,564	$410,527	$247,977	$39,324	$125,154	$83,599
Wages	$30,053,790	$11,156,704	$16,151,227	$2,745,859	$28,927,165	$10,856,454	$15,629,069	$2,441,642	$1,126,625	$300,250	$522,158	$304,217
Contract work	$521,921	$195,468	$177,724	$148,729	$511,436	$189,225	$177,587	$144,624	$10,485	$6,243	$137	$4,105
Work on share of product	$1,164,955	$277,991	$777,739	$109,225	$1,164,315	$277,991	$777,099	$109,225	$640	....	$640	....
Miscellaneous expenses	$4,419,537	$2,044,522	$2,014,436	$361,579	$4,223,025	$2,008,492	$1,889,576	$324,957	$196,512	$36,030	$124,860	$36,622
Cost of supplies and materials	$14,677,977	$5,470,101	$7,953,299	$1,254,577	$14,081,894	$5,306,252	$7,660,827	$1,106,815	$596,083	$163,849	$293,472	$147,762
Ore sold and treated, short tons	8,464,023	3,222,980	5,108,251	132,792	8,464,023	3,222,980	5,108,251	132,792	....	....	....	....
Value of bullion contents:												
Gold	$54,023,002	$26,531,623	$26,107,659	$1,383,720	$51,520,030	$25,531,958	$24,746,100	$1,241,972	$2,502,972	$999,665	$1,361,559	$141,748
Silver	$18,563,353	$11,317,764	$6,530,997	$714,592	$18,561,793	$11,317,210	$6,530,100	$714,483	$1,560	$554	$897	$109
Lead	$10,199,325	$6,958,295	$3,136,101	$104,929	$10,199,325	$6,958,295	$3,136,101	$104,929	....	....	....	....
Other metals	$1,900,649	$624,466	$574,098	$102,083	$1,900,185	$624,468	$573,640	$102,077	$464	....	$458	$6
Total gross value	$84,086,329	$45,432,150	$36,348,855	$2,305,324	$81,581,333	$44,431,931	$34,985,941	$2,163,461	$2,504,996	$1,000,219	$1,362,914	$141,863
Average per ton	....	....	....	....	$10	$14	$7	$16	....	....	....	....
Value of product at mine	$68,327,754	$35,307,932	$31,578,495	$1,441,327	$65,831,994	$34,311,515	$30,220,570	$1,299,909	$2,495,760	$996,417	$1,357,925	$141,418
Average per mine	$63,325	$259,617	$51,431	$4,381	$71,247	$293,261	$56,487	$4,779	$16,102	$52,443	$17,189	$2,481

The preceding table shows that the dividend paying companies contributed over one-half of the output. Taking deep mines alone and eliminating companies with which production was merely incidental to development work, it will be observed that the grade of ore mined by dividend paying companies was worth $14 per ton, whereas the ore mined by nondividend paying companies was worth only $7.

Employes and wages.—The average number of wage-earners employed in gold and silver mines was 47,905 men, of whom 33,821 were employed in deep mines, 2,321 in placer mines, and 11,763 in mines reporting only development work. Their total wages amounted to $47,658,176. In any analysis of these figures it must be borne in mind that the above number of wage-earners is an average, computed on the basis of 300 working days, and is not identical with the actual number of persons who earned the amount of wages reported. The average per wage-earner accordingly represents the cost of one man's labor to the employer, which is not identical with the average annual earnings. For the purpose of estimating the earning capacity of wage-earners, average daily rates should be consulted.

The following table shows the distribution of wage-earners according to daily rates of pay for the several classes of employees:

TABLE 12.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL CLASSES.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE EARNERS.	
	Average number.	Per cent of total.	Average number	Per cent of total.	Average number	Per cent of total.	Average number.	Per cent of total	Average number.	Per cent of total.	Average number	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	47,905	100.0	2,129	100.0	553	100.0	3,405	100.0	28,068	100.0	3,864	100.0	574	100.0	33	100.0	9,279	100.0
Less than 0.50	16	(1)													5	15.2	11	0.1
0.50 to 0.74	72	0.2							11	(1)	25	0.7			7	21.2	29	0.3
0.75 to 0.99	397	0.8	7	0.3	4	0.7	13	0.4	172	0.6	112	2.9			5	15.2	84	0.9
1.00 to 1.24	544	1.1	30	1.4	19	3.4	19	0.6	242	0.9	78	2.0			3	9.1	153	1.7
1.25 to 1.49	351	0.7	15	0.7	1	0.2	36	1.1	183	0.6	28	0.7			5	15.2	83	0.9
1.50 to 1.74	506	1.1	9	0.4	5	0.9	16	0.5	249	0.9	53	1.4	4	0.7	3	9.1	167	1.8
1.75 to 1.99	718	1.5	3	0.2	5	0.9	13	0.4	250	0.9	103	2.7					344	3.7
2.00 to 2.24	1,536	3.2	8	0.4	19	3.4	80	2.3	439	1.6	180	4.7	2	0.3	5	15.2	803	8.7
2.25 to 2.49	928	1.9	2	0.1	9	1.6	23	0.7	337	1.2	210	5.4	2	0.3			345	3.7
2.50 to 2.74	6,641	13.9	51	2.4	77	13.9	161	4.7	3,633	12.9	916	23.7	66	11.5			1,737	18.7
2.75 to 2.99	3,603	7.5	28	1.3	28	5.1	81	2.4	2,829	10.1	142	3.7	26	4.5			469	5.1
3.00 to 3.24	15,994	33.4	460	21.6	169	30.6	682	20.0	10,101	36.0	1,188	30.7	191	33.3			3,203	34.5
3.25 to 3.49	1,922	4.0	94	4.4	5	0.9	136	4.0	981	3.5	259	6.7	29	5.1			418	4.5
3.50 to 3.74	10,043	21.0	478	22.5	158	28.6	791	23.2	6,921	24.7	554	14.3	210	36.6			931	10.0
3.75 to 3.99	468	1.0	45	2.1	3	0.6	73	2.1	299	1.1	5	0.1	9	1.6			34	0.4
4.00 to 4.24	3,544	7.4	762	35.8	46	8.3	998	29.3	1,358	4.8	11	0.3	32	5.6			337	3.6
4.25 and over	622	1.3	137	6.4	5	0.9	283	8.3	63	0.2			3	0.5			131	1.4

[1] Less than one-tenth of 1 per cent.

As shown by the above table, practically all of the wage-earners in gold and silver mines received $2 per day or over. When the figures for the several classes are combined it is found that 93.3 per cent of the total number received between $2 and $4.24. The statistics show a very large concentration of the wage-earners in three rate groups, as follows: 13.9 per cent of the total number in group $2.50 to $2.74, 33.4 per cent in group $3 to $3.24, and 21 per cent in group $3.50 to $3.74. Most of the employees included in these groups probably received the even rates $2.50, $3 or $3.50 per day.

More than half of the wage-earners were returned as miners. Their wages ranged between narrow limits, 87.2 per cent of the total number having been paid from $2.50 to $3.74 per day. In the rate group $3 to $3.24 are included 36 per cent of all the miners reported. There were also 3,864 men returned as miners' helpers, about one-seventh the number of miners. The rates of pay for these helpers were somewhat lower than those paid to the miners.

The rates paid to engineers, machinists, and other mechanics were higher than those of the other wage-earners; 92.8 per cent of the engineers and 86.9 per cent of the machinists and other mechanics received $3 per day or over. At $4 or more the respective proportions were 42.2 and 37.6 per cent. The rates for firemen were somewhat lower, a much greater proportion of them having been paid less than $3 per day. The range of wages for 79.1 per cent of the firemen was from $2.50 to $3.74 per day. There were 574 timbermen and track layers reported, all but 8 of whom received $2.50 per day or more. The daily rates for the great part of these employees were probably $3 or $3.50, as 33.3 per cent of them are included in the group $3 to $3.24, and 36.6 per cent in the group $3.50 to $3.74.

The boys under 16 years employed in gold and silver mines numbered only 33, and constituted less than one-tenth of 1 per cent of the total number of wage-earners. Five of these boys received less than 50 cents a day, and the rest of them were paid between 50 cents and $2.24.

The group of "all other wage-earners" includes 9,279 men who were not reported under the more specific heads. The rates of pay for these employees were somewhat lower than those for the wage-earners already considered, about one-fifth (21.8 per cent) having been paid less than $2.50 per day. The majority of them, however, received at least $2.50 and a large proportion received considerably more than that. The group showing the greatest number of employees is that from $3 to $3.24; in that one group are included 34.5 per cent of all the wage-earners in this class.

Table 13 shows the distribution of wage-earners according to daily rates of pay for those states which employed on the average more than one thousand wage-earners. In addition to the number included in each rate group, the percentages which these numbers form of the state total are given and also the cumulative percentages which show for each rate the proportion of the total number receiving that rate or more.

TABLE 13.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY STATES AND TERRITORIES: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			ARIZONA.			CALIFORNIA.			COLORADO.			IDAHO.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	47,905	100.0	....	3,686	100.0	...	9,136	100.0	....	13,503	100.0	....	4,234	100.0	....
Less than 0.50	16	(1)	100.0				1	(1)	100.0				1	(1)	100.0
0.50 to 0.74	72	0.2	99.9				1	(1)	99.9	1	(1)	100.0			99.9
0.75 to 0.99	397	0.8	99.8	1	(1)	100.0	1	(1)	99.9	1	(1)	99.9	3	0.1	99.9
1.00 to 1.24	544	1.1	99.0	7	0.2	99.9	16	0.2	99.9	8	0.1	99.9	22	0.5	99.9
1.25 to 1.49	351	0.7	97.9	27	0.7	99.8	30	0.3	99.8	6	(1)	99.9	13	0.3	99.4
1.50 to 1.74	506	1.1	97.2	135	3.7	99.1	105	1.1	99.5	15	0.1	99.9	8	0.2	99.1
1.75 to 1.99	718	1.5	96.1	148	4.0	95.4	220	2.4	98.4	160	1.2	99.8	10	0.2	98.9
2.00 to 2.24	1,536	3.2	94.6	241	6.5	91.4	393	4.3	96.0	327	2.4	98.6	36	0.9	98.7
2.25 to 2.49	928	1.9	91.4	35	1.0	84.9	472	5.0	91.7	77	0.6	96.2	14	0.3	97.8
2.50 to 2.74	6,641	13.9	89.5	188	5.1	83.9	3,077	32.6	86.7	1,360	10.1	95.6	64	1.5	97.5
2.75 to 2.99	3,603	7.5	75.6	115	3.1	78.8	1,250	13.7	54.1	935	6.9	85.5	86	2.0	96.0
3.00 to 3.24	15,991	33.4	68.1	874	23.7	75.7	2,835	30.1	40.4	6,529	48.3	78.6	1,184	28.0	94.0
3.25 to 3.49	1,922	4.0	34.7	173	4.7	52.0	193	2.1	10.3	606	4.5	30.3	625	14.8	66.0
3.50 to 3.74	10,043	21.0	30.7	1,229	33.4	47.3	488	5.2	8.2	1,541	11.4	25.8	1,831	43.2	51.2
3.75 to 3.99	468	1.0	9.7	19	0.5	13.9	40	0.4	3.0	264	2.0	14.4	12	0.3	8.0
4.00 to 4.24	3,541	7.4	8.7	418	11.4	13.4	200	2.2	2.6	1,488	11.0	12.4	277	6.6	7.7
4.25 and over	622	1.3	1.3	75	2.0	2.0	36	0.4	0.4	185	1.4	1.4	48	1.1	1.1

RATE PER DAY (DOLLARS).	MONTANA.			NEVADA.			SOUTH DAKOTA.			UTAH.			ALL OTHER STATES AND TERRITORIES.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	2,759	100.0	....	1,649	100.0	....	3,436	100.0	....	4,295	100.0	....	4,918	100.0	....
Less than 0.50				2	0.1	100.0				1	(1)	100.0	11	0.2	100.0
0.50 to 0.74						99.9						99.9	67	1.4	99.8
0.75 to 0.99				1	0.1	99.9						99.9	390	7.9	98.4
1.00 to 1.24	1	(1)	100.0	1	0.1	99.8				10	0.2	99.9	479	9.7	90.5
1.25 to 1.49			99.9			99.7				6	0.1	99.8	269	5.5	80.8
1.50 to 1.74			99.9	65	3.9	99.7	10	0.3	100.0	1	(1)	99.7	167	3.4	75.3
1.75 to 1.99	1	(1)	99.9	16	1.0	95.8			99.7	6	0.1	99.7	147	3.0	71.9
2.00 to 2.24	3	0.1	99.9	14	0.8	94.8	18	0.5	99.7	153	3.6	99.6	335	6.8	68.9
2.25 to 2.49			99.9	2	0.1	94.0	1	(1)	99.2	238	5.6	96.0	89	1.8	62.1
2.50 to 2.74	20	0.7	99.9	46	2.8	93.9	242	7.1	99.2	1,121	26.2	90.4	523	10.6	60.3
2.75 to 2.99			99.2	76	4.6	91.1	4	0.1	92.1	936	21.8	64.2	161	3.3	49.7
3.00 to 3.24	436	15.8	99.2	641	38.9	86.5	1,068	31.0	92.0	1,297	30.3	42.4	1,134	23.1	46.4
3.25 to 3.49	29	1.1	83.4	57	3.5	47.6	8	0.2	61.0	140	3.3	12.1	91	1.8	23.3
3.50 to 3.74	1,816	65.8	82.3	217	13.2	44.1	1,852	53.9	60.8	274	6.4	8.8	795	16.2	21.5
3.75 to 3.99	46	1.7	16.5	8	0.5	30.9	6	0.2	6.9	36	0.8	2.4	37	0.8	5.3
4.00 to 4.24	337	12.2	14.8	418	25.3	30.4	145	4.2	6.7	59	1.4	1.6	193	3.9	4.5
4.25 and over	70	2.6	2.6	85	5.1	5.1	86	2.5	2.5	7	0.2	0.2	30	0.6	0.6

[1] Less than one-tenth of 1 per cent.

Of the states for which statistics are presented separately in the above table, rates were highest in Montana. Practically all of the wage-earners in that state received at least $3 per day, and 82.3 per cent of them were paid $3.50 or over. In the single group $3.50 to $3.74 are included 65.8 per cent of all the wage-earners and a large proportion of these probably received exactly $3.50 per day.

In South Dakota, Idaho, and Nevada the rates paid were somewhat less than in Montana, but between the three states there was, on the whole, comparatively little difference. At first glance it would seem that of the three states rates were highest in Nevada, for that state shows an exceptionally large proportion of wage-earners at $4 and over. It will be noticed, however, that the proportions at $3 or more and at $3.50 or more are greater in South Dakota and Idaho than in Nevada, while the proportions receiving less than $3 are smaller. Of the wage-earners in South Dakota, 53.9 per cent are included in the single group $3.50 to $3.74, and 31 per cent in the group $3 to $3.24. In Idaho 86 per cent are included in three consecutive groups, constituting the range from $3 to $3.74 per day. There was a greater divergence in the wages paid in Nevada, the group including the greatest number of employees being that from $3 to $3.24, and the one including the next largest number being that from $4 to $4.24.

Following the states above mentioned in the order of the rates paid come Colorado and Arizona. In these two states, also, there was on the whole comparatively little difference in wages. In Colorado the range of wages for 94.2 per cent of the wage-earners was from $2.50 to $4.24 per day, 48.3 per cent being included in the single group $3 to $3.24. In Arizona the wage-earners were distributed in smaller groups over a wider range. Practically all of them (97.1 per cent) received between $1.50 and $4.24 per day. The greatest concentration in Arizona is at $3 to $3.50 per day, 23.7 per cent being included in group $3 to $3.24 and 33.4 per cent in group $3.50 to $3.74.

Of the states which employed, on the average, more than one thousand wage-earners, California and Utah show the lowest rates. In each of these states the greater part of the wage-earners received between $2.50 and $3.24 per day, the proportion included between those limits being 76.4 per cent for California and 78.3 per cent for Utah.

It will be noticed that the statistics grouped under "all other states and territories" include practically all the returns for wage-earners receiving less than $1.50 per day. This is due to the inclusion of several Southern states, in which rates of wages were low. They reported a comparatively small number of wage-earners. The employees at the higher rates included under "all other states and territories" were principally in Oregon, New Mexico, and Washington, where rates were approximately the same as in the Western states, for which a separate showing is made in Table 13.

In addition to regular wage-earners employed by the day or by the task, there is a special class of labor variously designated as "leasers," "block lessees," "tributers," "chloriders," etc. Technically, they "lease" from the operator a block in the mine and "pay" a stipulated royalty, which varies with the richness of the ore; in reality all the ore hoisted is usually delivered to the operator and marketed by him, or else it is shipped in his name to the sampler or smelter; the operator retains his royalty, or authorizes the ore buyer to withhold the same, and pays to the "lessees" their share of the proceeds. In all cases these workers furnish their own mine supplies. While resembling in form an ordinary mining lease, this is in substance a contract of employment on a share of the product.

The average number of miners employed on a share of the product in 1902 was 1,280, and the total compensation received by them amounted to $1,452,692, which included the cost of supplies furnished by them. This system is in vogue chiefly in Colorado, which reported 158 mines worked on shares, with 823 "leasers." California had 27 such mines; Montana, 18; Nevada, 7; Idaho, 3; New Mexico, 3; Arizona, 3; Oregon, 2; and Georgia and North Carolina, 1 each.

A summary of mines employing this class of labor is presented in the table next following. Deep mines are divided into two groups—those worked on shares only and those employing both share and wage workers. There were only 2 placer mines reported as having both classes of labor; these 2 mines are therefore omitted from the table. The mines worked exclusively on shares were small. The larger mines where this system was practiced also employed regular wage-earners.

TABLE 14.—*Summary for mines worked on shares: 1902.*

	DEEP.			PLACER.
	Total.	Without wage labor.	With wage labor.	Without wage labor.
Number of mines	203	162	41	18
Number of owners working	11	11		
Salaries	$219,218	$19,224	$199,994	
Wages	$1,093,176		$1,093,176	
Contract work	$35,555	$9,120	$26,435	$137
Share workers—				
Number	1,122	447	675	130
Amount paid	$1,375,843	$557,602	$818,241	$64,256
Miscellaneous expenses	$236,959	$39,266	$197,693	$2,335
Cost of supplies and materials	$487,298	$18,055	$469,243	$1,880
Ore sold and treated, short tons	331,526	57,158	274,368	
Value of bullion contents—				
Gold	$3,513,849	$709,241	$2,804,608	$89,004
Silver	$1,236,262	$292,107	$944,155	
Other metals	$223,479	$64,815	$158,664	$223
Total gross value	$4,973,590	$1,066,163	$3,907,427	$89,227
Average per ton	$15	$18	$14	
Value of product at mine	$3,585,254	$728,886	$2,856,366	$88,105
Average per mine	$17,664	$4,160	$20,258	$4,895

There are a number of gold and silver mines in which manual labor is performed by the owners, either with or without the assistance of hired help. The total number of owners so employed in producing mines was reported as 1,495 and the number so engaged in mines under development was 609. There were in all 599 producing mines and 281 under development which employed no hired labor at all. It must be borne in mind, however, that the census agents were instructed to omit from their canvass mines where less than two wage-earners were employed. The above numbers, therefore, include only such mines as were reached by correspondence and those which were supposed from preliminary information to come within the scope of the canvass, but were found upon personal inquiry by special agents to employ no hired labor. The total number of men engaged in working their own mines without hired labor, or with but casual help, must be considerably larger than the number reported.

A summary for mines operated without hired labor, as far as reported, is presented in the following table:

TABLE [illegible].—*Summary for mines operated without hired labor: 1902.*

	Total.	Placer.	Deep.
Number of mines	[illegible]	396	203
Number of owners working	1,165	774	391
Contract work	$1,685		$1,685
Miscellaneous expenses, total	$31,094	$18,537	$12,557
Rent and royalties	$26,007	$15,100	$10,957
Mines and mineral lands	$18,[illegible]	$8,112	$10,651
Water	$2,[illegible]	$2,517	$210
Other	$1,[illegible]	$1,471	$81
Other miscellaneous expenses	$5,187	$3,437	$1,[illegible]
Cost of supplies and materials	$41,715	$21,298	$20,417
Ore sold or treated, short tons	9,332	....	9,332
Average per deep mine	46	....	46
Total gross value	$528,496	$293,176	[illegible]
Average per ton	$25	....	$25
Treatment charges and freight	$46,928	$1,407	$11,[illegible]
Value of product at mine	$482,568	$291,769	[illegible]
Average per mine	$806	$737	[illegible]

The average output per mine, as shown in the preceding table, was less than one thousand dollars; the output of ore in an average deep mine operated without hired labor was 46 tons, and there were about two owners working in an average mine. It is evident that the work did not occupy the entire time of the owners. This must be borne in mind if it is desired to make comparisons with other mines. Ore bringing $25 per ton is considered a high-grade product.

The mines at which owners were reported to be doing manual labor include cooperative mines, the number of which was 25. Of this number there were 11 mines each of which reported less than five men employed.

The term "cooperative" as applied to such mines is somewhat vague. A "cooperative association" consisting of from two to four men, often working by turns and devoting to the work only such time as can be spared from other occupations, is not easily distinguished from an ordinary partnership. If 5 members be considered the minimum for a cooperative association, there were 14 such associations, with 171 working members; in addition to these, 1 man was hired for wages. Of these associations, 1 with 12 working members was incorporated, with a capital stock of $60,000, and upon this capital a dividend of 6 per cent was paid. This mine is also included among those owned by incorporated companies. The greatest number of men reported by a single association was 23. Twelve associations, with a combined membership of 136 men, were engaged in placer mining, and 2 with 35 men were operating deep mines. The membership of these associations included 101 Chinese and 70 persons of all other nationalities. The Chinese were working exclusively in placer mines. There were in all 8 associations composed exclusively of Chinese, with a total membership of 95 men; the greatest number reported by any Chinese association was 16. There were 5 associations, with a total membership of 68 men, composed of other nationalities and 1 with a mixed membership.

The total output of all cooperative associations was valued at the mine at $92,313, averaging $6,594 per mine. The mines are grouped by the value of production, as follows: One with an output of less than $500; 3 with an output exceeding $500 but less than $1,000; 7 with an output exceeding $1,000 but less than $10,000; and 2 with an output exceeding $10,000 but less than $50,000.

Contract work.—An amount of contract work in and about the mines was done by individuals, firms, and companies making a specialty of certain classes of work. The total amount paid for contract work was $2,168,861, of which $1,542,771 was paid at mines where development work alone was prosecuted, and $626,090 at producing mines. The latter amount was nearly all expended in development work, such as tunneling, shaft sinking, drifting, running levels and winzes, etc. Mining proper (stoping) was only in two cases reported as being done by contract along with development work, the total expenditure for contract work in these two cases amounting to $46,888. Pumping was reported in two cases only, the total amount being insignificant. In a few cases cutting and hauling of wood and timber, roadmaking, and building and cleaning of ditches were reported, the total expense amounting to $15,414.

The number of men employed on contract work could not always be stated accurately by mine operators, for the reason that they had no direct control over the men employed by the contractors. Very frequently the number of men to be furnished by the contractor was stipulated in the contract. Still the time consumed by them in doing the work was in most cases not stated; therefore the number of men could not be reduced to an annual average basis of 300 working days, and duplications could not be avoided. The same men working in a mining camp on a number of mines successively were reported by several operators. The total number reported for producing mines was 980 men, whereas in mines reporting development work only, the number of men employed by contractors aggregated as many as 5,649. The number of men reported in each class of mines shows an extreme disproportion to the amounts paid for contract work. It is apparent that in some cases the number of men must have been underestimated, whereas in others there were probably many duplications.

The several classes of labor presented under the head of "employees and wages" and "contract work" comprise an average of 47,905 regular wage-earners, 1,280 workers for a share of the product, 2,104 owners doing manual labor, and 6,629 men employed by contractors. In addition to these, 5,135 prospectors reported 5,519 mining claims, upon which, in compliance with the mining laws, the sum of $551,900 ought to have been expended in assessment work. Considering that many mines were operated only at certain seasons and that during a portion of the year the miners had to employ their time in other industries, it may be conservatively estimated that from 50,000 to 60,000 men found employment in gold and silver mining.

Time in operation.—Tables 16, 17, 18, 19, and 20 present a classification of producing mines by the number of days in operation, number of shifts employed per day, and number of hours per shift, and a like classification of all mills whenever separately reported.

For a number of the mills combined with mines only one report was made for both mill and mine, in which case the report was included with the number of mills. There were, as stated on a preceding page, 599 mines in which no hired labor was employed, not including 162 mines where all miners were working on a share of the product, and 2,393 mines and mills with regular wage-earners. Many of the two former classes failed to report the number of days and hours in operation. The number of mines reporting the days in operation was 2,525, and the number reporting the hours in operation was 2,494. The total number of mines shown in Tables 18 and 19 includes a duplication of 34 mines which reported different hours for various classes of employees. All other mines reported the same hours for all employees.

TABLE 16.—*Number of mines, classified according to number of days in operation, by states and territories: 1902.*

STATE OR TERRITORY.	Total number reporting.	DAYS. 30 and less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 365.
United States	2,525	96	211	218	253	201	197	169	131	127	294	176	452
Alabama	3	1			1						1		
Arizona	67	1	9	4	2	4	8	3	6	3	2	3	22
Arkansas	1										1		
California	812	36	69	73	93	62	64	68	29	30	109	49	130
Colorado	648	19	50	49	45	53	35	34	38	52	88	70	115
Georgia	43	4	6	4	3	5	3	7	1		8	1	1
Idaho	206	9	21	24	35	21	13	13	10	4	20	2	34
Maryland	1				1								
Montana	175	6	7	11	19	13	19	9	11	6	14	15	45
Nevada	74	1	4	4	3	4	6	3	5	5	13	5	21
New Mexico	82	5	12	10	8	6	4	7	5	7	7	6	5
North Carolina	13				2			1	2		8		
Oregon	240	8	27	32	32	21	32	19	16	10	11	13	19
South Carolina	3	1									2		
South Dakota	38	2	1	1	3	5	2	1	1	1	3	3	15
Tennessee	2						1				1		
Texas	1												1
Utah	84		2	1	2	4	6	3	5	5	5	7	38
Virginia	4	1				1				1		1	
Washington	27	2	2	2	4	2	3	1	2	2	1	1	5
Wyoming	4		1				1			1			1

TABLE 17.—*Number of mills, classified according to number of days in operation, by states and territories: 1902.*

STATE OR TERRITORY.	Total number reporting.	DAYS. 30 and less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 365.
United States	482	81	76	40	36	31	23	17	13	24	34	17	90
Alabama	1	1											
Arizona	29	6	6	3		1		1	1		1	3	7
California	235	42	38	21	19	19	13	6	10	10	11	2	44
Colorado	71	4	8	6	4	4	2	3	1	4	6	6	23
Georgia	10	2	2	1	2		1				1		1
Idaho	45	12	9	1	2	3	1	1			6	1	6
Montana	9	2			1	2		1		1		2	
Nevada	24	3	4		1		3			2	4	2	5
New Mexico	18	5	4	4	1		1	2		1			
North Carolina	1				1								
Oregon	6	1	1		3	1							
South Carolina	1										1		
South Dakota	10			1	1			1		4		1	2
Utah	17	2	1		1	1	1	2	1	2	4		2
Virginia	1		1										
Washington	2		1				1						
Wyoming	2	1	1										

TABLE 18.—*Number of mines and mills in the United States, classified according to number of working shifts per day, and number of hours per shift: 1902.*

HOURS IN OPERATION.	MINES. Total reporting.	Running 1 shift.	Running 2 shifts.	Running 3 shifts.	MILLS. Total reporting.	Running 1 shift.	Running 2 shifts.	Running 3 shifts.
United States	2,528	1,767	621	140	479	166	276	37
Less than 8 hours	13	13						
8 hours	929	589	200	140	60	10	13	37
9 hours	362	270	92		15	11	4	
10 hours	1,099	872	227		69	58	11	
11 hours	9	3	6		4	2	2	
12 hours	116	20	96		331	85	246	

TABLE 19.—NUMBER OF MINES, CLASSIFIED ACCORDING TO NUMBER OF WORKING SHIFTS PER DAY, AND NUMBER OF HOURS PER SHIFT, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Total reporting.	RUNNING 1 SHIFT. Total.	Less than 8 hours	8 hours	9 hours	10 hours	11 hours	12 hours	RUNNING 2 SHIFTS. Total.	Less than 8 hours	8 hours	9 hours	10 hours	11 hours	12 hours	RUNNING 3 SHIFTS. Total.	Less than 8 hours	8 hours	9 hours	10 hours	11 hours	12 hours
United States	2,528	1,767	13	589	270	872	3	20	621		200	92	227	6	96	140		140				
Alabama	3	2				2			1				1									
Arizona	70	43			13	28		2	20		2	3	13		2	7		7				
Arkansas	1	1				1																
California	812	571	3	62	131	365	1	9	191		8	24	118		41	50		50				
Colorado	659	461	4	360	65	32			174		114	44	12		4	24		24				
Georgia	37	31				30	1		6						6							
Idaho	203	140	2	31	10	91	1	5	55		4	6	29	1	15	8		8				
Maryland	1	1				1																
Montana	174	111	1	77	2	31			43		30		7		6	20		20				
Nevada	74	46		15	5	26			23		6	4	7		6	5		5				
New Mexico	82	68		8	24	36			13		3	2	7		1	1		1				
North Carolina	12	9				8		1								3		3				
Oregon	246	203	2	10	12	176		3	37		1	4	13	5	14	6		6				
South Carolina	3	1				1			2				2									
South Dakota	39	26			1	25			11			1	9		1	2		2				
Tennessee	2	2				2																
Texas	1	1				1																
Utah	82	34	1	24	4	5			34		31	2	1			14		14				
Virginia	4	3				3			1				1									
Washington	19	9		2		7			10		1	2	7									
Wyoming	4	4			3	1																

TABLE 20.—NUMBER OF MILLS, CLASSIFIED ACCORDING TO NUMBER OF WORKING SHIFTS PER DAY, AND NUMBER OF HOURS PER SHIFT, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Total reporting.	RUNNING 1 SHIFT.							RUNNING 2 SHIFTS.							RUNNING 3 SHIFTS.						
		Total.	Less than 8 hours.	8 hours.	9 hours.	10 hours.	11 hours.	12 hours.	Total.	Less than 8 hours.	8 hours.	9 hours.	10 hours.	11 hours.	12 hours.	Total.	Less than 8 hours.	8 hours.	9 hours.	10 hours.	11 hours.	12 hours.
United States	479	166	....	10	11	58	2	85	276	....	13	4	11	2	246	37	....	37	....	....	....	....
Alabama	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Arizona	28	17	....	....	1	5	....	11	10	....	....	....	....	....	10	1	....	1	....	....	....	....
California	235	91	....	1	5	32	1	52	132	....	2	2	6	2	120	12	....	12	....	....	....	....
Colorado	72	11	....	4	1	2	....	4	52	....	2	....	1	....	49	9	....	9	....	....	....	....
Georgia	9	3	....	....	....	2	....	1	6	....	....	1	....	....	5	....	....	....	....	....	....	....
Idaho	44	15	....	1	2	8	....	4	29	....	....	....	1	....	28	....	....	....	....	....	....	....
Montana	9	1	....	....	....	....	....	1	1	....	1	....	....	....	....	7	....	7	....	....	....	....
Nevada	24	5	....	....	....	2	....	3	17	....	1	1	1	....	14	2	....	2	....	....	....	....
New Mexico	18	10	....	....	....	3	1	6	8	....	1	....	....	....	7	....	....	....	....	....	....	....
North Carolina	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Oregon	6	3	....	....	....	....	....	3	3	....	....	....	....	....	3	....	....	....	....	....	....	....
South Carolina	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....
South Dakota	10	....	....	....	....	....	....	....	10	....	....	....	2	....	8	....	....	....	....	....	....	....
Utah	16	5	....	4	....	1	....	....	6	....	6	....	....	....	....	5	....	5	....	....	....	....
Virginia	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Washington	2	....	....	....	....	....	....	....	2	....	....	....	....	....	2	....	....	....	....	....	....	....
Wyoming	2	2	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Supplies and materials and miscellaneous expenses.—The general term "materials" has scarcely any application to mining. The "material" operated upon in a mine is the rock underground or the gold bearing gravel. The inquiry calling for "total cost of supplies and materials of all kinds used during the year" at the mine contained the following explanatory note:

"The cost of the following materials should be reported under this inquiry: Lumber and timber used for repairs, mine supports, track ties, cars, and for all other purposes; iron and steel for blacksmithing; rails, frogs, sleepers, etc., for tracks and repairs; parts of machinery and tools used for renewals and repairs; explosives, water for boilers and for other purposes; fuel, illuminating and lubricating oils, machinery supplies, etc."

All the items here enumerated come strictly under the definition of "supplies." The "material" treated at the mills is the ore which comes from the mine. It is not customary in mining bookkeeping to charge the mill with the value of the ore brought from the mine. In the schedule relating to "reduction works, other than smelters," there were two separate inquiries, one relating to "materials," another to "supplies." The former called for a statement of the "character of materials used, whether ore, tailings, or other materials," and was confined to "materials bought in 1902." The amount reported in answer to this inquiry is not included in the cost of "supplies and materials" but is given elsewhere as a separate item.

The explanatory note to the inquiry relating to mill "supplies" enumerated: "Shoes, dies, screens, plates, and other parts of machinery and tools used for renewals and repairs; quicksilver, cyanide of potassium, lumber, iron, steel, oil, fuel, water, etc."

The total cost of "supplies and materials," as herein defined, was reported as $21,774,845, distributed as follows: Producing mines, deep, $15,908,782; placer, $790,986; developing mines, $5,075,077.

The item, "miscellaneous expenses," includes rent and royalties of all descriptions, "taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere."

The total amount of miscellaneous expenses of producing mines was $5,357,529, of which $1,419,155 was reported as rents and royalties of all descriptions for mines, and $3,938,374 for all other mine expenses and miscellaneous mill expenses; the latter item includes the sum of $4,244 paid by custom mills as royalties for the privilege of reworking old tailings.

The miscellaneous expenses of developing mines aggregated $1,017,356, of which rents and royalties of all descriptions amounted to only $71,131. That the amount of rents and royalties paid by this class of mines was so insignificant is in harmony with the character of the mines, royalties and rents being as a rule proportionate to the returns of the mine. Where the mine is not producing, the labor and expense incurred by the operator in developing the mine are a part consideration for the privilege of working the same.

Of the items making up the total royalties ($71,131), the principal expense ($41,916) was for the use of water, and the next largest sum ($16,153) was expended for electric power; other power (air, steam, etc.), cost $2,406; the rents of mines and mineral lands amounted to $4,528; expenditures on plant and improvements were $3,572; for tunnel privileges, $843; and rent of office and miscellaneous rents, $1,713.

The following is a statement of rents and royalties paid by producing mines:

Rents and royalties paid by producing mines: 1902.

	All mines	Deep	Placer
Total	$1,419,155	$1,273,288	$145,867
Mines and mineral lands	696,372	649,565	46,807
Plant and improvements	84,721	80,544	4,177
Tunnel privileges	64,282	64,257	25
Water rent	287,010	243,346	43,664
Electric power	215,802	165,916	49,886
Air and steam power	2,111	2,111	
Miscellaneous rents	68,857	67,549	1,308

The greater part of the royalties paid for the use of the mines and mineral lands, $500,550, was reported from Colorado; the amount reported by all other states was only $195,822. Royalties for tunnel privileges were reported as follows: Colorado, $43,954; Nevada, $12,482; Utah, $7,266; all other states, $580. The most of the payments for water rents, $210,641, was reported from California; the next largest sum, $40,707, was reported from Colorado, while all other states aggregated $35,662. The amount expended for rent of electric power was $215,802, of which $128,077 was reported from California and $87,725 from Colorado. The rent of other power was exceptional.

The royalties do not include those charged to so-called "block lessees," "tributers," etc., who made no reports to the census. Where the mine was worked by regular wage-earners as well as by tributers the amount charged against the latter as royalties could not be segregated. But where this was the only class of labor employed in mining the amount charged as royalties can be ascertained by deducting the amount paid to the lessees from the total value realized for the ore at the mine.

Mineral lands.—The primary distinction between mining and manufacturing is that in the latter only capital and labor are factors, while in the former industry there are three factors of production, viz, land, capital, and labor. The present census of mines and quarries is the first in which the scope of the inquiry has in some branches been extended to the ownership of mineral lands. Though the special schedule providing for gold, silver, lead, and copper mines confined itself to mineral lands, it is probable that in some cases the reports included lands of all descriptions, such as timbering lands, building lots, etc.

The acreage of mineral lands was reported for 5,845 mines, viz: Producing, deep, 1,913; producing, placer, 846; mines in the development stage, 3,086. No report of acreage was made for 178 producing, and for 166 developing, mines; these constituted 5.5 per cent of the total. The area reported by producing mines was 406,009 acres, of which 219,349 acres belonged to deep mines and 186,660 acres to placers; 653,001 acres were reported by mines under development. This shows that the area held for development exceeds by more than one-half the acreage of producing mines.

The leasing of mineral lands had only a subordinate part in gold and silver mining. The total area rented was 58,807 acres, 33,259 acres by operators of producing mines and 25,548 acres for development. The total royalties paid for the use of mineral lands amounted to $696,372, of which $46,807 was paid on placers and $649,565 for deep mines. In Table 21 all mines reporting acreage are arranged by the area owned and leased, by the character of mine, and by states and territories. The number of mines contains a duplication of 68 mines which were located on land partly owned and partly leased.

TABLE 21.—CLASSIFICATION OF MINES ACCORDING TO ACREAGE, BY STATES AND TERRITORIES: 1902.

	UNITED STATES.			ALABAMA.		ARIZONA.		ARKANSAS.		CALIFORNIA.		COLORADO.		GEORGIA.	
	Number of mines reporting.	Acreage		Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.
		Total	Per cent												
Producing mines:															
Deep—															
Land owned—															
Total	1,761	205,384	100.0	3	1,800	67	10,725	1	700	401	48,353	534	40,341	7	1,160
20 acres or less	465	7,263	3.5	....	....	6	165	....	....	139	2,571	232	2,469	3	60
21 to 99 acres	768	29,286	14.3	....	....	25	1,152	....	....	135	7,491	211	9,391	1	40
100 to 999 acres	499	113,732	55.4	2	300	36	9,408	1	700	122	26,539	85	19,861	3	1,060
1,000 acres and over	29	55,103	26.8	1	1,500	....	....	....	....	5	11,752	6	8,620	....	....
Land leased—															
Total	404	13,965	100.0	1	470	3	300	....	....	35	1,572	249	5,778	4	215
20 acres or less	264	3,235	23.2	....	....	....	....	....	....	21	242	180	1,719	2	40
21 to 99 acres	111	5,071	36.3	....	....	1	50	....	....	8	430	62	2,368	2	175
100 to 999 acres	29	5,659	40.5	1	470	2	250	....	....	6	900	7	1,691	....	....
Placer—															
Land owned—															
Total	787	167,366	100.0	1	80	2	740	....	....	467	83,881	17	[illegible]	3	1,250
20 acres or less	146	3,541	2.1	....	....	....	....	....	....	139	2,384	3	60	1	20
21 to 99 acres	273	14,519	8.7	1	80	....	....	....	....	165	8,717	1	40	....	....
100 to 999 acres	286	81,321	48.6	....	....	2	740	....	....	147	41,042	9	[illegible]	2	1,230
1,000 acres and over	82	67,985	40.6	....	....	....	....	....	....	16	31,738	4	6,173	....	....
Land leased—															
Total	75	19,294	100.0	1	80	....	....	....	....	39	10,713	3	740	1	708
20 acres or less	13	241	1.2	....	....	....	....	....	....	9	151	....	....	....	....
21 to 99 acres	28	1,379	7.2	1	80	....	....	....	....	15	558	1	40	....	....
100 to 999 acres	29	8,397	43.5	....	....	....	....	....	....	14	1,727	2	700	1	708
1,000 acres and over	5	9,277	48.1	....	....	....	....	....	....	1	8,277	....	....	....	....
Development work without product on owned and leased:															
Total	3,086	653,001	100.0	3	3,700	363	70,387	2	80	353	173,048	915	83,461	2	330
20 acres or less	681	[illegible]	[illegible]	....	....	29	566	....	....	97	1,740	601	4,672	1	30
21 to 99 acres	1,076	59,858	9.2	....	....	90	6,263	2	80	102	5,891	150	16,452	....	....
100 to 999 acres	1,277	291,221	[illegible]	2	900	240	58,698	....	....	142	39,517	157	30,877	1	300
1,000 acres and over	47	101,151	15.5	1	2,800	4	4,860	....	....	11	25,900	6	11,840	....	....
10,000 to 99,999 acres	4	[illegible]	13.5	....	....	....	....	....	....	....	....	1	[illegible]	....	....
100,000 acres and over	1	100,000	15.3	....	....	....	....	....	....	1	100,000	....	....	....	....

TABLE 21.—CLASSIFICATION OF MINES ACCORDING TO ACREAGE, BY STATES AND TERRITORIES: 1902—Continued.

	IDAHO.		MARYLAND.		MONTANA.		NEVADA.		NEW JERSEY.		NEW MEXICO.		NORTH CAROLINA.		OREGON.	
	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.
Producing mines:																
Deep—																
Land owned—																
Total	211	19,216			150	14,980	67	8,253			61	15,072	9	3,580	65	9,397
20 acres or less	16	308			40	690	23	408			14	264	1	15	8	160
21 to 99 acres	42	2,335			33	1,745	17	941			25	1,428	1	55	21	1,367
100 to 999 acres	149	11,156			75	8,985	26	5,384			20	5,780	6	2,460	36	7,870
1,000 acres and over	4	5,417			2	3,560	1	1,520			2	7,600	1	1,050		
Land leased—																
Total	15	581	1	120	44	1,583	7	308			15	782	1	643	4	160
20 acres or less	11	179	1	120	30	581	5	123			6	108			2	40
21 to 99 acres	2	78			10	562	1	85			8	414			2	120
100 to 999 acres	2	324			4	440	1	100			1	260	1	643		
Placer—																
Land owned—																
Total	76	17,180			25	12,868	13	11,215			5	804	4	1,106	164	27,532
20 acres or less	13	220			3	60	6	60					1	13	27	526
21 to 99 acres	26	1,398			5	342	3	155			1	26	1	40	68	3,631
100 to 999 acres	35	10,262			11	4,866	1	320			4	778	2	1,053	65	17,035
1,000 acres and over	2	5,300			6	7,600	3	10,680							4	6,340
Land leased—																
Total	4	1,080			2	679	1	20			6	3,231	1	150	15	1,753
20 acres or less							1	20			1	20			3	60
21 to 99 acres	1	60									4	211			5	290
100 to 999 acres	3	1,020			2	679							1	150	7	1,403
1,000 acres and over											1	3,000				
Development work without production:																
Owned and leased—																
Total	324	44,374	1	65	124	38,384	73	18,158	1	1,692	146	50,322	24	16,692	181	28,691
20 acres or less	42	802			33	577	13	249			12	189	1	8	12	211
21 to 99 acres	152	7,898	1	65	35	2,061	19	1,213			58	3,158	10	604	71	4,510
100 to 999 acres	125	26,094			54	9,086	38	11,287			75	14,790	9	3,310	96	20,870
1,000 acres and over	5	9,580			1	1,660	3	5,409	1	1,692			4	12,770	2	3,100
10,000 to 99,999 acres					1	25,000					1	32,185				
100,000 acres and over																

	SOUTH CAROLINA.		SOUTH DAKOTA.		TENNESSEE.		TEXAS.		UTAH.		VIRGINIA.		WASHINGTON.		WYOMING.	
	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.	Number of mines reporting.	Acreage.
Producing mines:																
Deep—																
Land owned—																
Total	2	3,150	32	12,257			1	620	62	12,711	1	275	20	2,256	4	448
20 acres or less			5	69					3	47			5	77		
21 to 99 acres			11	866					32	1,933			9	411	2	100
100 to 999 acres			13	3,646			1	620	25	7,472	1	275	6	1,768	2	348
1,000 acres and over	2	3,150	3	7,676					2	3,259						
Land leased—																
Total			3	192					19	1,158	2	133	1	20		
20 acres or less			1	10					4	53			1	20		
21 to 99 acres			1	55					12	661	2	133				
100 to 999 acres			1	127					3	444						
Placer—																
Land owned—																
Total			1	240					1	160	1	107	7	412		
20 acres or less													3	52		
21 to 99 acres													2	120		
100 to 999 acres			1	240					1	160	1	107	2	240		
1,000 acres and over																
Land leased—																
Total					1	80							1	60		
20 acres or less																
21 to 99 acres					1	80							1	60		
100 to 999 acres																
1,000 acres and over																
Development work without production:																
Owned and leased—																
Total			111	41,116					251	37,292	3	2,176	138	25,290	88	16,614
20 acres or less			4	55					19	344			9	180	8	150
21 to 99 acres			30	1,847					86	1,773			51	3,104	31	2,009
100 to 999 acres			73	22,194					145	33,275	2	882	75	16,606	48	8,455
1,000 acres and over			3	5,880					1	1,900	1	1,294	3	5,400	1	6,000
10,000 to 99,999 acres			1	11,140												
100,000 acres and over																

The preceding table shows the concentration of the ownership of mineral lands, both in deep and placer mines. By far the greater part of all mineral lands is held in plots of 100 acres or more, representing an aggregation of five or more original locations. This concentration is especially conspicuous in mining properties which are now being developed; four-ninths of all such mineral lands are held by 52 operators. One mining property in California extends over an area of 100,080 acres.

The correlation between the area of mineral lands and value of production is shown in the following table:

TABLE 22.—*Classification of deep and placer mines by acreage and value of product: 1902.*

	Number of mines.[1]	ACREAGE.		VALUE OF PRODUCT AT MINE.			
		Total.	Per cent.	Total.	Per cent.	Average per mine.	Average per acre.
Deep and placer mines	2,937	406,009	100.0	$78,151,089	100.0	$26,609	[2]$188
20 acres or less	921	13,644	3.4	7,476,142	9.6	8,117	548
21 to 99 acres	963	49,602	12.2	20,144,263	25.8	20,918	406
100 to 999 acres	808	208,772	51.4	38,258,629	48.9	47,350	183
1,000 acres and over	67	133,991	33.0	10,335,376	13.2	154,259	77
Acreage not reported	178	....	......	1,936,679	2.5	10,880	......
Deep mines	1,959	219,349	100.0	73,961,544	100.0	37,755	[2]330
20 acres or less	716	9,989	4.6	7,265,756	9.8	10,148	727
21 to 99 acres	670	33,939	15.5	19,635,727	26.6	29,307	579
100 to 999 acres	498	119,842	54.6	35,902,968	48.5	72,094	300
1,000 acres and over	29	55,579	25.3	9,474,168	12.8	326,695	170
Acreage not reported	46	....	......	1,682,925	2.3	36,585	......
Placer mines	978	186,660	100.0	4,189,545	100.0	4,284	[2]21
20 acres or less	205	3,655	2.0	210,386	5.0	1,026	58
21 to 99 acres	293	15,663	8.4	508,536	12.1	1,736	32
100 to 999 acres	310	88,930	47.6	2,355,661	56.2	7,599	26
1,000 acres and over	38	78,412	42.0	861,208	20.6	22,663	11
Acreage not reported	132	....	......	253,754	6.1	1,922	......

[1] Exclusive of 85 custom mills.

[2] The product on which this average is computed does not include that for mines which do not report acreage.

It appears from the preceding table that the value of the mining product bore no direct relation to the area of mineral lands owned or leased. The average production per acre decreased as the area increased; the three owners of the largest acreage were among the smallest producers. It is probable that while the smaller properties were under active operation the larger were awaiting development. Still the value of the average production per mine increased with the increased ownership of mineral lands, though not in the same ratio.

The following table shows in parallel columns the royalties paid and the value of product of deep mines operated on leased land only. It covers 10,872 acres, i. e., 78 per cent of all lands leased by deep mines. Operators, 55 in number, who owned mineral lands in addition to the lands leased are omitted.

TABLE 23.—*Value of product and royalties of deep mines operating on leased land only: 1902.*

STATE OR TERRITORY.	Number of mines.	Value of product at mine.	RENT AND ROYALTIES FOR MINERAL LANDS.	
			Total.	Per cent of product.
United States	330	$3,240,986	$510,818	15.8
California	30	188,547	18,195	9.7
Colorado	193	2,190,840	379,521	17.3
Georgia	5	6,089	734	12.0
Idaho	14	43,906	6,057	13.8
Montana	40	389,445	72,275	18.6
Nevada	5	128,265	3,591	2.8
New Mexico	14	106,173	11,233	10.6
South Dakota	3	54,234	6,271	11.6
Utah	16	111,145	5,460	4.9
All other states and territories[1]	10	24,332	7,481	30.7

[1] Includes Arizona, 2; Maryland, 1; North Carolina, 1; Oregon, 3; Virginia, 2; and Washington, 1.

The following is a summary of all the statistics for deep mines operated on leased land only:

TABLE 24.—*Summary for deep mines operated on leased land only: 1902.*

Number of mines	330
Number of owners working	139
Salaries	$195,917
Wages	$1,401,955
Contract work	$70,399
Work on share of product	$28,561
Rent and royalties of mines and mineral lands	$510,818
Other miscellaneous expenses	$110,182
Cost of supplies and materials	$590,914
Ore sold and treated, short tons	267,555
Value of bullion contents:	
Gold	$2,716,755
Silver	$1,187,171
Other metals	$601,386
Total gross value	$4,505,312
Average per ton	$17
Value of product at mine	$3,240,986
Average per mine	$9,821
Acreage leased	10,872
Average per mine	33

Mechanical power.—The total primary power used in gold and silver mines amounted to 195,805 horsepower, of which 122,354 was steam, 43,936 water, 4,060 gas or gasoline, and 8,003 other power, mostly compressed air. Of this total the rented horsepower aggregated 17,452, of which 14,469 horsepower was electric. In addition 750 electric motors, having a capacity of 32,003 horsepower, were reported owned by the operators. More than one half of all rented electric power was reported from California, the rest was nearly all used in Colorado.

The use of water as a motive power was a marked feature in California, which reported nearly one-half of all waterpower used, viz, 21,517 horsepower. The total horsepower of steam engines in that state was 16,858, and the total electric power owned and rented was 18,961. Thus water and electric power held a more prominent place in California than steampower.

Nearly all the power reported was used in deep mines; comparatively little was used in placers. The latter utilized chiefly water and electric power. The following table shows the quantity and kind of power used in producing mines, deep and placer:

TABLE 25.—*Power used in producing mines: 1902.*

	Total.	Deep.	Placer.
Total horsepower	195,805	184,512	11,293
Owned:			
Engines—			
Steam—			
Number	1,925	1,805	120
Horsepower	122,354	118,833	3,521
Gas or gasoline—			
Number	198	189	9
Horsepower	4,060	3,940	120
Water wheels—			
Number	788	686	102
Horsepower	43,936	40,206	3,730
Other power—			
Number	156	150	6
Horsepower	8,003	7,588	415
Rented:			
Electric, horsepower	14,469	10,982	3,487
Other power, horsepower	2,983	2,963	20
Electric motors owned:			
Number	750	607	143
Horsepower	32,003	27,758	4,245
Supplied to other establishments, horsepower	323	223	100

Over one-fourth of all deep mines and the bulk of the placer mines had no other motive power except hand and animal power. The aggregate product of the deep mines operated in this primitive way was very small, as compared with the total product of deep mines, being valued at only $1,730,469, or 2 per cent. In placer mining, however, the reverse was the case, the major part of the placer product of the United States being obtained without mechanical power.

The following table is a summary of deep mines which used no mechanical power. Regular producers are segregated from mines, the operations of which consisted mainly of development work, to which production was merely incidental:

TABLE 26.—*Deep mines using hand and animal power only: 1902.*

	Total.	Producing.	Developing and producing.
Number of mines	563	330	233
Number of owners working	319	250	69
Salaries	$135,991	$62,247	$73,744
Wages	$1,144,414	$616,835	$527,579
Contract work	$60,041	$21,206	$38,835
Work on share of product	$175,998	$172,900	$3,098
Miscellaneous expenses	$145,217	$113,959	$31,258
Cost of supplies and materials	$282,432	$149,858	$132,574
Ore sold and treated, short tons	116,435	101,528	14,907
Gross value of product	$2,485,978	$2,221,421	$264,557
Average per ton	$21	$22	$18
Value of product at mine	$1,730,469	$1,557,438	$173,031
Average per mine	$3,074	$4,719	$742

The following table is a comparative summary of placers according to the power used, whether mechanical or other:

TABLE 27.—*Placer mines using mechanical or other power: 1902.*

	Total.	Mines with mechanical power.	All other.
Number of mines	[1] 967	155	812
Salaries	$318,313	$204,191	$114,122
Wages	$1,769,612	$826,826	$942,786
Contract work	$19,816	$14,318	$5,498
Work on share of product	$73,517	$33,153	$40,364
Miscellaneous expenses	$271,844	$179,832	$92,012
Cost of supplies and materials	$781,236	$531,363	$249,873
Value of product at mine	$4,058,189	$2,115,722	$1,942,467
Average per mine	$4,197	$13,650	$2,392
Method of treatment:			
Dredging [2]	45	45	
Hydraulicking	471	52	419
Other methods	451	58	393

[1] Does not include 8 mines with stamp mills.

[2] Includes 1 mine using electric elevator.

The following is a comparative table of steam engines and horsepower reported for 1902, 1889, 1880, and 1870. The previous censuses did not distinguish producing mines from those where the work was confined to development; the results for 1902, in Table 28, therefore, combine both classes of mines. While the total horsepower used shows a remarkable increase, the average power per engine has remained practically the same. In 1870 it was 44 horsepower; in 1880, 46 horsepower; in 1889, 40 horsepower; and in 1902, 55 horsepower.

TABLE 28.—*Steam engines and horsepower, by states and territories: 1870 to 1902.*

STATE OR TERRITORY.	1902		1889		1880		1870	
	Number of engines.	Horsepower.	Number of engines.	Horsepower.	Number of engines.	Horsepower.	Number of engines.	Horsepower.
United States	2,890	158,363	1,362	54,822	525	24,206	107	4,743
Alabama	11	313	1	(1)				
Arizona	212	9,306	60	1,030	17	369		
Arkansas	1	65						
California	482	19,933	266	8,638	80	2,333	39	1,253
Colorado	951	60,265	502	18,972	135	3,190	15	488
Georgia	62	1,651	7	283	11	196		
Idaho	189	11,027	80	2,296	13	260	5	82
Maine					12	194		
Maryland	8	135	1	(1)				
Michigan			7	529				
Montana	265	12,570	86	4,239	19	608	1	10
Nevada	73	4,188	139	11,048	161	14,863	44	2,780
New Hampshire					2	55	1	15
New Mexico	135	6,156	62	1,912	2	45		
North Carolina	56	1,782	47	2,415	15	298		
Oregon	89	2,726	16	1,796	3	100		
South Carolina	9	450	4	210				
South Dakota	114	13,766	41	2,969	13	250		
Texas	1	25	2	66				
Utah	137	10,875	24	2,829	34	1,261		
Virginia	9	177	3	125	5	74	2	115
Washington	50	1,593	2	21				
Wyoming	36	1,360	12	449	3	110		

[1] Not reported.

The following table shows the machinery used at producing mines, deep and placer, as well as at those at which development work only was done:

TABLE 29.—MACHINERY, BY KINDS AND BY STATES AND TERRITORIES: 1902.

	HOISTS.						PUMPS.						ROCK DRILLS.					
	Total.	Steam.	Gas or gasoline.	Compressed air.	Water.	Electric.	Total.	Steam.	Gas or gasoline.	Compressed air.	Water.	Electric.	Total.	Steam.	Gas or gasoline.	Compressed air.	Water.	Electric.
United States	2,013	1,551	207	108	68	76	1,342	1,205	[illegible]	97	42	49	3,361	302	6	2,970	10	[illegible]
PRODUCING MINES.																		
Total	1,249	968	81	91	50	56	840	663	25	84	30	42	2,499	167		2,297	4	31
Deep	1,203	945	80	90	33	52	769	617	18	82	20	32	2,487	167		2,288	[illegible]	[illegible]
Placer	46	23	1	1	17	4	71	46	[illegible]	2	10	10	12			[illegible]	[illegible]	
Alabama	2	2					7	7					10	6		4		
Arizona	58	57	1				76	67	8	1			[illegible]	8		[illegible]		
Arkansas	2	2					3	3					4			4		
California	248	142	26	28	42	10	165	78	10	30	27	20	318	16		302	1	
Colorado	541	463	28	21		29	261	234		11	1	[illegible]	925	66		840	3	16
Georgia	27	24		1	1	1	[illegible]	40		2		1	35	4		27		4
Idaho	69	33	4	31	1		52	43		7	1	1	264	10		252		2
Maryland	2	2					1	1										
Montana	99	91	1		4	3	91	83		1		7	[illegible]	11		65		1
Nevada	33	19	7	5		2	7	3			1	3	[illegible]	1		28		
New Mexico	42	29	11			2	[illegible]	16	1				[illegible]	1		37		1
North Carolina	11	11					16	16					9			9		
Oregon	24	18	2	2	2		16	16					61			61		
South Carolina	6	6					4	4					7			7		
South Dakota	22	20		2			44	18		[illegible]		1	247	14		233		
Tennessee							2		2									
Texas	1	1																
Utah	58	46	2	1		9	33	13		20			189	27		162		
Virginia	1	1					10	10										
Washington	11	9	2				10	10					7	[illegible]		2		
Wyoming	2	2					2	1				1	10	1		9		
DEVELOPMENT WORK WITHOUT PRODUCTION.																		
Total	764	583	126	17	18	20	492	442	18	13	12	7	862	[illegible]	6	[illegible]	6	42
Alabama	1	1																
Arizona	141	73	66	2			[illegible]	32	8	[illegible]		1	121	7	1	88		22
California	[illegible]	[illegible]	11	5	11	2	[illegible]	35	[illegible]	[illegible]	1	2	119	6		[illegible]	1	[illegible]
Colorado	215	187	12	3		13	109	102	2	2	1	2	[illegible]	24		[illegible]		1
Georgia	2	2					3	3					1					
Idaho	31	27	2	2			22	21	1				[illegible]	[illegible]		[illegible]		2
Montana	36	35		1			41	41					[illegible]	4		[illegible]		
Nevada	40	22	16			2	21	19	2				18	[illegible]		12		
New Mexico	48	47	1				[illegible]	28	1				[illegible]	[illegible]	1	[illegible]		
North Carolina	11	10				1	12	10				2	13			8		
Oregon	24	20	2		2		[illegible]	10					[illegible]			[illegible]		1
South Dakota	22	20	1	1			[illegible]	24		1			[illegible]	[illegible]		11		
Utah	46	31	10	2		2	[illegible]	24					[illegible]	[illegible]		53		
Virginia	5	4	1				1	1					[illegible]	4				
Washington	19	14	2	2	1		[illegible]	11	1		1		[illegible]	11	1	[illegible]	2	
Wyoming	21	14	[illegible]				[illegible]	17		[illegible]			[illegible]	[illegible]		[illegible]		

The total number of hoists in producing mines reported was 1,249, of which number 968 were operated by steampower, the rest by other mechanical power. Aside from the 563 deep mines which used only hand and animal power, there were a number of mines which were reached by tunnels or adits at which hoists could be dispensed with. The following comparative table shows the number of steam hoists used at all deep mines, producing as well as those reporting development work without production, in 1902 and 1880:

TABLE 30.—*Steam hoists at deep mines, by states and territories: 1902 and 1880.*

STATE OR TERRITORY	1902	1880
United States	1,528	425
Alabama	3	......
Arizona	130	17
Arkansas	2	......
California	191	71
Colorado	648	127
Georgia	23	6
Idaho	55	11
Maine	......	11
Maryland	2	......
Montana	122	19
Nevada	41	100
New Hampshire	......	2
New Mexico	76	2
North Carolina	20	10
Oregon	12	5
South Carolina	6	......
South Dakota	40	6
Texas	1	......
Utah	77	34
Virginia	5	1
Washington	23	......
Wyoming	21	3

The following table shows the pumps used in all deep mines, producing as well as those reporting development work without production, in 1902 and 1880:

TABLE 31.—*Pumps at deep mines, by states and territories: 1902 and 1880.*

STATE OR TERRITORY.	KIND OF POWER.					
	Total.		Steam		All other	
	1902	1880	1902	1880	1902	1880
United States	1,261	159	1,059	154	202	5
Alabama	7	......	7	......	......	......
Arizona	179	4	156	4	23	......
Arkansas	3	......	3	......	......	......
California	196	28	106	24	90	4
Colorado	359	25	336	25	23	......
Georgia	34	8	33	8	1	......
Idaho	66	3	57	3	9	......
Maine	......	9	......	9	......	......
Maryland	1	......	1	......	......	......
Montana	120	10	114	10	6	......
Nevada	28	32	22	31	6	1
New Mexico	45	1	43	1	2	......
North Carolina	26	10	24	10	2	......
Oregon	25	2	25	2	......	......
South Carolina	4	......	4	......	......	......
South Dakota	69	3	42	3	27	......
Utah	47	16	37	16	10	......
Virginia	10	4	10	4	......	......
Washington	25	......	23	......	2	......
Wyoming	19	4	18	4	1	......

The total number of pumps used in 1902 was 1,261, of which number 1,059 were operated by steam and 202 by other power. Of this number, 769 were used in producing deep mines, 71 in productive placers, and 421 in mines under development. Some mines are drained by tunnels. The total number of producing deep mines being 2,017, it is apparent that a great many mines were not troubled with water and could therefore dispense with pumping machinery.

A noteworthy feature is the development of the use of power other than steam for operating pumping apparatus. In 1880 there were in all 4 pumps operated by water and 1 by compressed air; in 1902 the number of pumps operated by compressed air had increased to 97, the number operated by water to 42, and in addition 49 were run by electric power and 39 by gas or gasoline.

The following table shows the number of power drills at all deep mines in 1902 and 1880, by states and territories:

TABLE 32.—*Number of power drills at deep mines, by states and territories: 1902 and 1880.*

STATE OR TERRITORY	1902	1880
United States	3,329	257
Alabama	10	......
Arizona	216	1
Arkansas	4	......
California	631	16
Colorado	1,168	26
Georgia	33	......
Idaho	296	2
Maine	......	6
Montana	126	1
Nevada	50	195
New Mexico	71	......
North Carolina	22	......
Oregon	69	......
South Carolina	7	......
South Dakota	302	3
Utah	232	4
Virginia	4	4
Washington	44	
Wyoming	31	

The total number of power drills reported at producing mines in 1902 was 2,499, of which number 2,297 were operated by compressed air, 167 by steam, 31 by electricity, and 4 by water. Power drills were used in 353 mines. Among them were 5 placer mines, with a total of 12 drills, used in working ancient river beds by drifting; of the number reported, 5 were not in use during the year 1902. Comparison with the Tenth Census shows a remarkable progress in the use of power drills. In 1880 there were in all 257 power drills in use; in 1902 the number was 3,329.

The comparative results of working with power drills and by hand are shown in Table 33. Only deep mines are included; 26 mines using power drills furnished incomplete information on the subject and are therefore omitted.

TABLE 33.—*Comparison of power drills and hand power at deep mines: 1902.*

	All mines.	Mines using power drills.	Mines using hand power.
Number of mines	1,909	322	1,587
Number of drills used	2,358	2,358	....
Tons of ore mined in 1902:			
Total	9,966,406	7,340,536	2,625,870
Average per mine	5,220	22,797	1,655
Wages below ground	$24,268,800	$14,991,375	$9,277,425
Average wages per ton	$2.43	$2.04	$3.53

The preceding table shows that three-fourths of the total quantity of ore came from mines using power drills. The average product per mine with power drills was 22,797 tons, whereas the average per mine where no power drills were used was only 1,655 tons. The saving in labor below ground effected by the use of power drills, as compared with mining by hand, amounted to $1.49 per ton.

Of the machinery especially designed for placers, dredges were used in 44 mines. There were also 32 steam shovels in use, of which 21 were used in producing placer mines, and 11 in mines at which development work only was done.

The majority of deep mines have adopted mechanical power for conveying their ores to the reduction works; a very large number, however, still adhere to the old-fashioned way of carrying the ore in wagons. The former numbered 1,182 and the latter 925. The length of railroad tracks on the surface was 168 miles; underground, 945 miles. The number of locomotives was reported as 49. Of this mileage, 3 miles on the surface and 25 underground were reported for placer mines which were operated by drifting.

Water plants.—An abundant supply of water is one of the prime conditions of successful mining, especially in placers. The gold and silver mines were equipped with extensive water plants, which included 3,927 miles of ditches, flumes, etc.—2,992 miles for placer mines, or an average of over 3 miles per mine, and 935 miles for deep mines, or less than one-half mile per mine. The following table shows the length of water ditches, flumes, and pipes, by states and territories, for placer and deep mines:

TABLE 34.—*Water plants—length of ditches, flumes, pipes, etc., by states and territories: 1902.*

	All classes.		PRODUCING MINES.						Development without production.	
			Total.		Deep.		Placer.			
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Miles.*	*Feet.*	*Miles.*	*Feet.*	*Miles.*	*Feet.*
United States	4,606	325	3,926	4,771	935	289	2,991	4,482	679	834
Alabama	0	3,890	0	3,640	0	1,000	0	2,640	0	250
Arizona	113	4,254	58	1,129	57	1,129	1	......	55	3,125
Arkansas	0	1,400	0	1,400	0	1,400	......	......	......	......
California	1,939	1,477	1,706	3,119	335	3,332	1,370	5,067	232	3,638
Colorado	216	1,420	166	852	75	4,732	90	1,400	50	568
Georgia	113	1,265	77	4,445	33	325	44	4,120	35	2,100
Idaho	700	4,946	599	2,396	110	1,658	489	738	101	2,550
Montana	230	960	198	2,730	54	4,850	143	3,160	31	3,510
Nevada	62	4,340	36	1,600	35	3,180	0	3,700	26	2,740
New Mexico	47	3,042	43	4,862	24	4,822	19	40	3	3,460
North Carolina	1	1,600	1	1,300	0	1,300	1	0	0	300
Oregon	959	2,881	867	2,543	41	5,111	825	2,712	92	338
South Dakota	77	2,585	69	305	68	3,785	0	1,800	8	2,280
Tennessee	0	2,500	0	2,500	......	......	0	2,500	......	......
Utah	88	4,345	80	1,110	80	210	0	900	8	3,235
Virginia	1	4,360	0	4,640	0	2,000	0	2,640	0	5,000
Washington	20	4,490	7	1,470	3	2,000	3	4,750	13	3,020
Wyoming	30	3,380	12	1,500	12	1,500	......	......	18	1,880

Production.—The value of the total production of gold and silver mines in continental United States in 1902 was $82,482,052, of which $77,154,326 was produced by deep mines and $5,327,726 by placer mines. In determining the value of the product at mine, the method of valuation adopted in the mining industry was followed by the census. The value of the ore and bullion is determined in accordance with a well established trade custom, in the following manner: The ore is sampled and assayed, and the price per ton is determined in accordance with the assay contents. Gold, if exceeding in value $1 per ton, is paid for at the coining rate of $20.67 per ounce, or very often at the commercial rate of $20 per ounce; sometimes a further discount of 5 per cent is made, i. e., of $1 per ounce to cover losses in reduction. Silver is paid for at the New York market quotation, usually with a discount of 5 per cent for losses in smelting. Lead is paid for at the New York quotation, usually with a discount of 10 per cent for losses in smelting, and with a further reduction of 2 cents per pound of fine lead contents for freight to New York. Copper is paid for at a stipulated price, depending upon the New York quotation, but usually from 4 to 6 cents below the same; an allowance is made for iron and manganese, if present in sufficient quantities; no allowance is made for zinc, but on the contrary a penalty is charged if the percentage of zinc exceeds a fixed maximum. After the gross price per ton has thus been determined a stipulated charge per ton is deducted for sampling, assaying, and treatment, and the balance represents the value of the ore at which the total value of the shipment is computed.

The freight charges for carrying the ore from the mine to the works are borne by the mine operator. Usually the freight is paid by the buyer and deducted from the agreed value of the shipment, and a check for the balance is delivered to the mine operator. Thus, as a rule, the value of the ore at mine is not a speculative quantity, but an amount appearing on the books of the mine operator. Where the mine is situated at a distance from a railroad station, the operator usually hauls the ore to the station by his own teams, and the cost of haulage is included in the operating expenses. Where a number of mines are centered in one camp, haulage is more frequently done by teamsters who make a specialty of hauling ore from the mines to the railroad station and bringing back supplies to the mines. Under ordinary circumstances the hire per ton will not vary during the year and can be accurately stated. This is true even if no separate account of it is kept by the operator, in which case the cost of haulage is included in the amount reported for freight. When the ore is of a very low grade, or where the mine is located at a great distance from the railroad station, and the cost of haulage is paid by the mine operator, it sometimes happens that the value realized does not repay the cost of shipping. A few such cases were reported for 1902, and the value of the product was shown as a "net loss."

The value of bullion when sold to the United States mints or assay offices is determined by assay; gold contents are paid for at the coining rate of $20.67 per fine ounce, and the silver contents at a price fixed from time to time by the Director of the Mint; a small charge is made for smelting and refining. When bullion is sold to private parties, banks, bullion dealers, etc., it is usually sold at a net price per crude ounce; the difference between the coining value of the fine gold contents and that paid by the buyer represents the expenses of refining and marketing the bullion, commissions, interest, etc. When the bullion is shipped by express the cost of expressage is deducted by the Mint and the balance is paid to the depositor of the bullion. Frequently bullion is sent by registered mail or brought to the Mint or bullion dealer personally by the owner. The cost of transportation is insignificant as compared with the value of the bullion, and may be treated as a negligible quantity. Thus the value received by the operator for his bullion always represents the value at his mine or works.

The following table shows in detail the manner in which the above-stated total value of the mining product was obtained:

TABLE 35.—*Value of product at mine: 1902.*

Placer mines		$4,188,795
Deep mines and mills connected with same. Ore and bullion sold		71,688,106
Mills operating on old dumps and tailings		361,045
Custom mills. Ore and bullion sold		8,310,854
Amount earned by all mills for custom work		847,334
Estimated value of increase of stock of ore		1,888,408
Estimated product of small mines:		
Placer		1,138,181
Deep		495,654
Total		$88,918,307
LESS.		
Net loss reported by mines	$3,926	
Decrease of stock on hand, estimated value	25,215	
Cost of purchased ores	6,293,915	
Freight paid on purchased ores	112,290	
Total		$6,435,275
Net total		$82,483,032

The values shown for placer bullion and for ore and bullion produced by deep mines and mills represent the amounts reported by the operators. There is a separate item showing the product of the treatment of old dumps and tailings. This represents the output of mills which operated exclusively on old dumps and tailings. The treatment of ore from dumps and tailings, which was incidental to the operations of all mills, is included in their total output.

The ore and bullion sold by custom mills represent only the products of ores purchased by those mills. When the ore was merely treated for a stipulated compensation and the dressed ore (concentrate) or bullion was returned to the owner, the amount earned for the treatment of the ore only was considered as belonging to the production of the mill. The value of the ore or bullion itself was not included in the product of the mill, inasmuch as it would have been a duplication of the value received by the mine owner for his product. Moreover, it was only in exceptional cases that the mill operator was able to report the value of such ores, inasmuch as his charges were not dependent upon the value of the ore and he had no interest to keep an account of the same. On the contrary, the product of the purchased ores was always reported. In order to eliminate duplications, the cost of purchased ores and freight paid on the same are deducted in the preceding statement from the total value reported.

The increase and decrease of the stock on hand represent the differences between the value of the stock on hand at the beginning and at the close of the year. In accounting for the mining production of a given year these differences must be taken into consideration, inasmuch as the product actually sold or treated during the year does not represent the returns for the mining expenses incurred during the same year. In individual cases the difference may be considerable. The value of the increase or decrease of stock of ore is necessarily an estimate. The value was computed at this office, taking as a basis in each case the value reported by the operator for the marketed ore and assuming the average value per ton of the increase or decrease of stock on hand to have been the same as that of the marketed ore. The decrease of stock represented ore mined in previous years and marketed during the year 1902. Though the grade of that ore may have been different from that of the ore mined during this year, yet for statistical purposes the assumption of one average value for all ore treated was correct. Where there was an increase of the stock of ore, however, it would be often unsafe to assume the average value of the ore on the dumps to be the same as that of the ore actually sold or treated. The ore may have been sorted and the better grade sold, the ore left on the dumps being of a low grade which it would not pay to ship, or a few test shipments may have been made which did not represent the average grade of ore. In order to guard against such errors no estimate was made of the value of the increase of stock whenever the same exceeded the actual quantity sold, unless, upon a comparison of the returns for ore actually sold with the outlay for mining, it appeared probable that more paying ore had been mined than sold and that the ore on hand was merely awaiting treatment. In all doubtful cases inquiries were addressed to the operators, and these, as a rule, were answered promptly and satisfactorily.

Nor were any estimates made of the increase of the stock of ore in cases where the mine was equipped with a mill. When the expenses of the latter were not reported separately there was no basis for estimating the cost of milling the ore, and none but the gross value of the same could be estimated; moreover, the fact that the ore was not milled raised the presumption, at least in some cases, that it did not pay to treat it. Thus the value of the increase of stock of ore is probably rather underestimated than overestimated.

There were a number of small mines, deep and placer, from which no report could be secured. Their output was ascertained from the best available sources, such as assay offices, local bullion dealers, and other reliable persons who, through business intercourse with the miners, had acquired information which enabled them to estimate the output of such mines with reasonable accuracy. These estimates, however, as will be shown later, seem to be below the actual production of this class of mines.

The value thus computed represents the value of the product of gold and silver mines for 1902. It must be understood that many small operators keep no books or records, and the amounts reported by them are approximations.

Bullion contents.—As explained above, the bullion contents of the ore were figured in detail in every settlement between mine operators and ore buyers. The statements rendered by the latter to the former are, in all well managed mines, kept on file and entered in detail in the books of the company. The same is done with United States Mint bullion returns. Not in all cases, however, are accounts kept with such accuracy, even in some of the larger mines. In such cases the bullion contents reported were of necessity estimated. The approximations, however, may be taken as reasonably accurate, inasmuch as the treatment charges did not vary widely for the same mine, while the freight per ton could be regarded as a constant quantity. In some cases the value alone was reported for each of the metallic elements of the ore; the number of ounces of gold and silver, and the pounds of lead and copper were then computed on the basis of the average value reported in other cases.

The total quantity of gold bullion produced by mills connected with mines was 1,666,515 ounces with a gross value of $34,062,535, or an average value of $20.44 per ounce. This was the rate realized by the operator, the difference of 23 cents representing the cost of refining and marketing the bullion. The gross value of the product of mines connected with mills includes the sum of $520,727, which represents net value, the refining charges on the bullion produced not having been reported. At the above average rate the cost of refining the above quantity must have been about $5,207, which, being added to the gross value, would increase the production by 252 ounces. The quantity is too small to be considered.

The number of fine ounces of gold produced by arrastras was not reported. The gross value, the treatment charges, and the net value alone were reported. The quantity was estimated upon the basis furnished by the reports of mines connected with mills.

The total value of the ore at the mine includes $495,654 reported from small mines, whose owners could not be located, and the product had to be ascertained from the best available sources. The amount so ascertained may in some cases have represented the net value realized by the miner for his ore. In others the estimates were apparently based upon the assumption that the values represented the metallic contents of the ore. The number of fine ounces of gold reported apparently represent an estimate at the coining rate of $20.67 per ounce of gold, or at the current commercial rate of $20 per ounce, and at the rate of 50 cents per ounce of silver.

For all these mines the average rate per ounce of gold was $20.17, which left about 50 cents for the cost of refining and marketing. Wherever the estimated value in reality represented net proceeds, this computation resulted in an underestimate of the quantity. Where, however, it represented gross value of metallic contents, it resulted in an overestimate of the net value produced. However, the amount is so small in proportion to the production of the United States that the effect of it upon the total product may be regarded as a negligible quantity.

Most of the placer mines failed to report the number of fine ounces of gold. There were 150 mines, which reported the gross value of the bullion, the cost of refining and expressage, and the value at the mine, viz. gross value of the bullion contents, $1,621,723; cost of refining and expressage, $9,530; value at mine, $1,612,193. The average cost of refining, etc., amounted to six-tenths of 1 per cent of the value, or 12 cents per ounce, leaving $20.55 as the value realized per ounce of placer gold. All other placer mines from which reports were received numbered 825, with an aggregate product valued at $2,583,272 at the mine. The average value per mine was $3,131, whereas the output of mines reporting charges averaged $10,748 per mine. Apparently the records were more complete with the larger mines. The average shown by them was taken as representing the general condition, and the number of fine ounces where the value only was reported was estimated at the rate of $20.55 per ounce.

Tables 36 and 37 present the bullion contents and the total gross value of the product of the mines and mills for 1902. The product of custom mills is not included, inasmuch as it represents the contents of ore bought from mine operators by whom it was presumably reported.

It is true the quantity treated during the year by reduction works would not exactly coincide with the quantity of ore sold by mine operators to the same class of works during the same year. Still the error is considered immaterial, and in no other way could duplications be avoided.

TABLE 36.—BULLION CONTENTS OF THE PRODUCT OF GOLD AND SILVER MINES CLASSIFIED BY CHARACTER OF MINE: 1902.

	Total value.	GOLD.		SILVER.		LEAD.		COPPER.		Zinc—value.	Other metals—value.[1]
		Fine ounces.	Value.	Fine ounces.	Value.	Fine pounds.	Value.	Fine pounds.	Value.		
United States	$99,093,070	3,149,128	$63,774,881	42,746,064	$21,448,851	411,038,434	$12,311,239	14,028,863	$1,016,204	$340,686	$201,209
Placer mines	5,343,176	259,143	5,340,087	4,303	2,235						854
Deep mines. Total	93,749,894	2,889,985	58,434,794	42,741,761	21,446,616	411,038,434	12,311,239	14,028,863	1,016,204	340,686	200,355
Mines without mill connection	34,226,861	1,058,964	21,197,571	20,160,820	10,140,501	87,026,083	2,149,386	6,468,683	508,324	166,767	64,312
Mines combined with mills	59,027,379	1,815,482	36,924,616	22,317,825	11,175,292	322,708,401	10,109,719	7,559,640	507,790	173,919	136,043
Estimated product of small mines	495,654	15,539	312,607	263,116	130,823	1,303,950	52,134	540	90		

[1] Includes allowance made for iron in ore, $73,911; quicksilver saved in reworking old tailings, $8,996; realized for old tailings whose contents could not be ascertained, $118,114; platinum, $198; osmiridium, $50.

TABLE 37.—BULLION CONTENTS OF THE PRODUCT OF GOLD AND SILVER MINES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	GOLD.		SILVER.		LEAD.		COPPER.		Zinc—value.	Other metals—value.
	Fine ounces.	Value.	Fine ounces.	Value.	Fine pounds.	Value.	Fine pounds.	Value.		
United States	3,149,128	$63,774,881	42,746,064	$21,448,851	411,038,434	$12,311,239	14,028,863	$1,016,204	$340,686	$201,209
Arizona	115,566	2,362,845	1,044,181	524,894	3,022,655	87,899	173,729	15,299		7
California	752,903	15,475,262	381,263	191,898	164,153	5,766	18,869	2,091		1,649
Colorado	1,321,215	26,100,459	13,681,856	6,846,380	81,001,564	1,827,993	5,196,124	386,158	335,436	131,808
Georgia	7,214	148,309	614	312	4,600	161	9,500	1,235		
Idaho	72,850	1,487,064	7,093,951	3,565,021	258,063,292	7,122,885	71,476	7,181		10,658
Montana	165,382	3,346,181	3,766,347	1,898,903	6,046,582	180,179	660,296	57,869		4,534
Nevada	87,244	1,771,322	3,781,278	1,892,832	3,721,983	111,718	11,651	1,098		4,295
New Mexico	17,317	358,412	276,269	142,823	2,881,325	80,976	720,519	61,725		3,000
North Carolina	3,226	65,722	1,975	1,025			45,234	5,961		
Oregon	89,001	1,827,935	112,920	58,046						96
South Carolina	6,749	139,389	226	113						
South Dakota	351,357	7,171,241	535,041	278,725	59,404	1,769	787	67		
Utah	146,668	2,976,188	11,406,273	5,686,160	105,811,357	2,873,740	7,120,148	477,101	5,250	45,292
Washington	11,004	219,895	381,440	191,848	83,185	2,937	540	90		
Wyoming	229	4,737			4,200	147				
All other states[1]	1,077	21,941	432,410	208,971	153,162	6,140				

[1] Includes Alabama, Arkansas, Maryland, Tennessee, Texas, and Virginia.

Gold and silver as by-products of other ores.—The product of gold and silver mines does not include the precious metal contents of copper and iron ores. The refined product which is placed on the market includes, on the other hand, the precious metal contents of all ores, regardless of their source of production. In order to make the mining product comparable with the refined product the following table is presented, in which the gold and silver contents of all ores, as well as of placer bullion, are shown:

TABLE 38.—*Gold and silver contents of the product of all mines: 1902.*[1]

SOURCE OF PRODUCTION.	GOLD.	SILVER.
	Fine ounces.	Fine ounces.
Total	3,242,069	55,819,946
Gold and silver ores and placer bullion	3,149,128	42,746,064
Copper ores	92,941	11,452,280
Iron ores		1,621,602

[1] Not including Alaska.

The gold and silver contents of copper ores shown in the preceding table are included in the value reported elsewhere for the product of copper mines, and the silver contents of iron ores are included in the value reported for iron ores.

The argentiferous iron ores exemplify the difficulties attending every classification. Such of these as contain high values in silver, which permit of their working for that metal, were classed as silver ores. With most of these ores, however, their chief value lies in the fluxing qualities of their iron and manganese contents, yet the value received for them by the mine operator represents practically nothing but the value of their silver contents. With the exception of a small quantity, the disposition of which was not reported, all this ore was sold to the American Smelting and Refining Company, which settles for it in the following manner:

The producer of the ore is paid in full for its silver contents at the New York quotation; the percentages of iron and manganese are added together and the percentage of silica is deducted from the sum. If the difference is equal to 40 per cent of the weight of the ore no charge, as a rule, is made for smelting and freight. A bonus is paid for every "unit"—i. e., 20 pounds—over the 40 per cent basis, usually at 15 cents per "unit"—i. e., three-fourths cent per pound—or a deduction is made at the same rate for every unit short of the 40 per cent basis. The value of the product classed as iron ore is made up as follows:

	Value
Silver (1,621,602 ounces)	$883,987
Allowance for other metals (copper, lead, iron, manganese)	66,716
Total gross value	950,703
Deductions	169,787
Value at mine	780,916

The average assay of silver was 7 ounces per ton, and the average gross value of the ore was $4.16 per ton; thus at the present price the value of the silver alone would not pay for the smelting of the ore but for the exceptionally low charge for smelting, viz, 74 cents per ton. The richness of the ore in iron and manganese is what makes such a low rate possible.

The following table is a summary of the mines producing argentiferous iron ore, not included in the statistics for gold and silver:

TABLE 39.—*Summary of mines producing argentiferous iron ore: 1902.*

Number of mines	17
Salaries	$38,580
Wages	$255,400
Contract work	$29,188
Work on share of product	$84,868
Rent and royalties	$85,474
Other miscellaneous expenses	$27,385
Cost of supplies and materials	$118,596
Ore sold, short tons	228,719
Gross value of bullion contents	$950,703
Average per ton	$4
Value of product at mine	$780,916

In the following table the gold and silver contents of all ores mined in 1902, including those in which the precious metals were merely by-products, are shown by states and territories:

TABLE 40.—*Gold and silver contents of all ores mined, by states and territories: 1902.*

STATE OR TERRITORY.	GOLD.		SILVER.	
	Fine ounces.	Value.	Fine ounces.	Value.
United States	3,645,789	$73,971,706	55,911,946	$28,214,854
Alaska[1]	403,730	8,345,900	92,000	48,760
Arizona	131,091	2,672,916	1,656,925	836,450
California	770,204	15,928,536	1,096,068	562,635
Colorado	1,321,930	26,414,800	15,173,061	7,740,227
Georgia	7,214	148,909	614	312
Idaho	72,868	1,487,362	7,094,558	3,566,238
Montana	197,535	3,990,359	13,441,950	6,833,963
Nevada	87,208	1,771,402	3,792,754	1,983,569
New Mexico	17,546	360,988	282,317	145,844
North Carolina	3,338	67,902	8,557	4,329
Oregon	89,026	1,829,176	112,920	58,046
South Carolina	6,749	139,389	226	113
South Dakota	351,357	7,171,241	535,041	278,725
Utah	173,591	3,590,413	11,782,147	5,817,997
Washington	11,028	229,875	390,440	196,348
Wyoming	229	4,737		
All other states[2]	1,085	21,941	462,958	221,078

[1] Estimate of the Director of the Mint.

[2] Includes Alabama, Arkansas, Maryland, Michigan, Tennessee, Texas, and Virginia.

Comparisons with the report of the Director of the Mint.—The Director of the Mint estimates annually, from the records of the United States mints and assay offices and from statements furnished by private refineries, the product of refined gold and silver from domestic ores. The methods followed in making these estimates are stated as follows:

> In estimating the gold yield of the United States in any given year only that gold is looked upon as really produced that has been refined, made ready for the market, and the ascertained amount of domestic origin (which is comparatively insignificant) that has been exported to foreign countries for reduction.
>
> It has been the custom of the Bureau of the Mint to make for every calendar year two independent calculations of the gold product of the country, and to take their mean as the closest approximation that can be had to the actual output of the mines. The first of these is based on the amount of gold put upon the market by private refineries during the year plus the fine gold contained in the unrefined bullion of domestic production deposited at the mints and assay offices of the United States plus the pure metal of domestic production contained in ores, copper matte, etc., exported to other countries for reduction. The second calculation is based on the known disposition made of the newly produced gold in any calendar year. Such gold is either deposited at the mints and assay offices of the United States, or exported from the United States in form of bullion, ores, or copper matte, or used in the industrial arts. If foreign gold bullion enters into any of the above items, its amount must, of course, be deducted.
>
> The silver product of the United States in any given calendar year is estimated in precisely the same manner as the gold product, namely, by making two independent calculations of the same and taking their mean as the actual product.[1]

The variance between these two estimates is confined within narrow limits. The variances for 1902 are as follows: For gold, 61,029 ounces, or about 1.5 per cent of either calculation; for silver, 66,972 ounces, i. e., somewhat over one-tenth of 1 per cent.

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1902, pages 13 and 14.

The precious metal contents of all ores mined in 1902, as ascertained by the census of mines and quarries in the continental United States, are collated in the following statement with the estimates of the Director of the Mint for the United States, exclusive of Alaska:

Precious metal contents, Bureau of the Census, and Mint returns: 1902.

	Product of mines reported by Census.	Refined product estimated by Director of the Mint.	DIFFERENCE.	
			Excess of mining product over refined product.	Excess of refined product over mining product.
Gold, fine ounces	3,242,039	3,466,270		224,231
Silver, fine ounces	55,819,916	55,408,000	411,916	

It appears from the preceding statement that the output of silver reported to the Bureau of the Census slightly exceeds the estimate of the Director of the Mint, whereas the product of gold reported to the Bureau of the Census is 6 per cent below the estimate of the Director of the Mint. At the Eleventh Census the difference was as high as 13 per cent of the refined product. The decline of placer mining and of mining on a small scale generally, the settlement of the mining districts and the improvement of transportation facilities, together with the progress of statistical methods have all contributed to making the returns of the present census more complete than its predecessors. On the other hand, there can be no coincidence between mine returns and the refined product for the same year, inasmuch as a part of the mining product of one year is refined during the following year.

The Mint agents in their reports show the distribution of gold between placer and deep mines by states and territories. In the following table the reports of Mint agents are compared with the results of the Census:

TABLE 41.—*Comparative statement of the gold contents of the product mined, as reported to the Bureau of the Census, and by Mint officers and agents, by states and territories: 1902.*

STATE OR TERRITORY	DEEP.		PLACER.	
	Census (fine ounces).	Mint officers and agents (fine ounces).	Census (fine ounces).	Mint officers and agents (fine ounces).
United States	2,982,896	3,191,561	259,143	321,410
Alabama	51	117	3	25
Arizona	130,578	199,140	513	2,101
Arkansas	484			
California	587,831	612,559	182,370	205,478
Colorado	1,316,758	1,348,048	3,172	31,444
Georgia	3,934	4,130	3,290	1,035
Idaho	55,777	38,500	17,091	34,547
Maryland	119	91		57
Montana	178,246	191,229	19,289	21,656
Nevada	85,825	144,211	1,423	757
New Mexico	11,924	12,297	6,722	6,312
North Carolina	3,184	3,727	154	803
Oregon	68,632	77,096	25,394	11,798
South Carolina	6,749	7,257		226
South Dakota	351,308	346,715	49	
Tennessee	8		275	7
Utah	173,580	192,157	11	
Virginia	112	181	33	27
Washington	10,664	15,115	364	5,000
Wyoming	229			2,198

The sources of production as reported by Mint officers and agents are arranged under two heads only, "quartz" and placer. It is evident by comparison with the Director's estimate of the refined product that the designation "quartz" includes all deep mines.[1]

The difference between the two sources compared in the preceding statement amounts to 62,267 ounces for placers and 208,665 ounces for deep mines, in all 270,932 ounces. It must be borne in mind, however, that the quantities reported by Mint officers and agents exceed the Director's estimate of the gold product in the continental United States by 46,691 ounces.

The excess over the Census returns for placer mines is greatest in Colorado, where the Mint officers report 31,444 ounces, whereas the Census returns show only 3,172 ounces. It seems probable that Colorado is erroneously credited by the officers of the Denver mint with the placer bullion produced in adjoining states, but shipped to Denver to be deposited at the United States Mint. The placer product credited to Idaho by the United States Assay Office, at Boise, is 17,456 ounces in excess of the Census returns; on the other hand, however, the Census returns show an excess of 13,596 ounces over the Mint report for Oregon; it is very likely that the Oregon product found its way through bullion dealers to the Boise assay office.

The gold product of placer mines, as reported to the Bureau of the Census directly by producers, was valued at $4,204,995, which corresponds to the value of 203,757 fine ounces, as estimated above. In addition to this amount the unreported production of small mines was estimated by local men at $1,138,181, which corresponds to the value of 55,386 fine ounces. Most of the placer bullion ultimately finds its way to the mints and assay offices. The report of the Mint officers and agents should therefore be given preference over the estimates of other local men. The excess of the amount reported by Mint officers and agents over the aggregate output reported directly by producers to the Bureau of the Census, viz, 123,903 ounces, with a coining value of $2,561,075, represents the product of small mines.

The excess of the gold product of deep mines as reported by Mint agents over the Census returns is greatest in Arizona and Nevada, namely, in Arizona, 68,562 ounces, which is equal to 52.5 per cent of the Census returns, and in Nevada 58,386 ounces—i. e., 68 per cent of the Census returns.

The following comparative table shows the distribution of the silver production by states, as ascertained by the census of mines and quarries and as estimated by the Director of the Mint. The quantities reported by Mint agents are shown in a parallel column.

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1902, page 16.

TABLE 42.—*Comparative statement of the silver contents of the product mined, as reported to the Bureau of the Census, and the product of silver refineries, as estimated by the Director of the Mint, by states and territories: 1902.*

[Fine ounces.]

	Census returns.	Estimate of the Director of the Mint.	Report of Mint agents.	Excess of Census returns over Mint estimates.	Excess of Mint estimates over Census returns.
United States	55,911,986	55,500,000	57,886,558	411,986	....
Alaska	¹92,000	92,000	89,588	....	....
Arizona	1,656,925	3,043,100	3,170,000	....	1,386,175
California	1,096,068	900,800	176,776	195,268	....
Colorado	15,173,061	15,676,000	15,800,958	....	502,939
Georgia	614	400	581	214	....
Idaho	7,094,558	5,854,800	5,942,714	1,239,758	....
Montana	13,441,950	13,243,800	13,029,787	198,150	....
Nevada	3,782,754	3,716,200	3,996,283	66,554	....
New Mexico	282,317	457,200	280,490	....	174,883
North Carolina	8,887	20,900	23,368	....	12,013
Oregon	112,920	98,300	109,463	14,620	....
South Carolina	229	300	580	....	71
South Dakota	385,041	370,200	351,000	14,841	....
Texas	432,385	446,200	556,106	....	13,815
Utah	11,782,147	10,831,700	12,678,037	950,447	....
Washington	390,440	619,000	721,480	....	228,560
Wyoming	....	5,000	5,200	....	5,000
All other states²	29,983	129,100	112,287	....	99,117

¹Estimate of the Director of the Mint.
²Includes Alabama, Maryland, Michigan, Tennessee, and Virginia.

Table 42 shows that while the Census returns for the United States, as a whole, substantially agree with the estimate of the Director of the Mint, there is a wide variance between the results for some of the states. The estimate of the Director of the Mint is 1,239,758 ounces, or 17 per cent short of the product ascertained by the Census for Idaho. On the other hand, the Census returns for Arizona are 1,386,175 ounces, or 45.5 per cent of the estimate of the Director of the Mint. Considering that the Census returns for other states, as well as the total for the United States, are in substantial harmony with the Mint estimates, it is not probable that the canvass of mines in Arizona by Census agents should have failed to reach 45.5 per cent of the silver product of that territory. Were it so, the difference for Arizona would have to be added to the Census total for the United States, in which case the estimate of the Director of the Mint would be 1,798,121 ounces below the total production of the United States. The Mint estimate of the total production for the United States, however, is more likely to be approximately accurate than its apportionment among the several states and territories, wherein the estimates of the Bureau of the Mint often widely disagree with the reports of its agents.

With special reference to Arizona, it is further possible that the excess of the Mint estimates over Census returns, both for the gold and the silver product, represents to some extent the product of Mexican mines brought over the border and sold in the United States.[1]

The Census returns for the silver product of Nevada slightly exceed the estimate of the Director of the Mint. Inasmuch as the silver product of Nevada usually occurs in association with gold, it would seem that the canvass of gold and silver mines must have been fairly complete. It is therefore difficult to account for the wide divergence between the Census returns and the Mint estimate of the gold product of the state. The vastness of the area to be covered and the sparseness of the population may to some extent have affected the Census returns; yet, considering that the variance between the Census returns and Mint estimates for other states is confined within comparatively narrow limits, it seems probable that Nevada has been credited by the Bureau of the Mint and its agents with much of the gold bullion brought from other states to the Carson City assay office.

Placer bullion usually carries silver; the quantity of silver, however, is in most cases too small to be figured in the value of the product. There were only 40 placer mines which reported separately the value of silver, amounting in all to $2,235. The reports of Mint agents, which are summarized in the statement below, place the coining value of silver at $12,752, corresponding to a commercial value of $5,129, at 52 cents per fine ounce.

The amount reported by Mint agents does not include the states of Colorado, Idaho, and Nevada. With the addition of the amount reported to the Bureau of the Census from these 3 states—viz, $1,444—the total value of the silver recovered as a by-product of placer mining amounts to $6,573. The difference between the Census returns and the Mint agents' estimates amounts to $4,338, which does not materially add to the silver production or reduce the gold production of the United States.

Gold and silver contents of placer bullion, as reported by Mint agents: 1902.[1]

	FINE OUNCES.		VALUE.		
	Gold.	Silver.	Gold.	Silver.	
				Commercial.	Coining.
United States	321,110	9,863	$6,638,268	$5,129	$12,752
California	205,468	5,450	4,247,002	2,834	7,046
Montana	21,629	2,417	447,046	1,257	3,125
Oregon	11,798	1,032	243,880	537	1,334
Washington	4,452	750	92,016	390	970
South Appalachian states²	2,140	214	44,252	111	277
All other states and territories³	77,248	(⁴)	1,596,785	(⁴)	(⁴)

¹Figures taken from the Report of the Director of the Mint on the Production of the Precious Metals for the Calendar Year 1902, pages 80, 144, 145, 184–187, and 212. Where only coining values were reported, fine ounces have been computed from such at a rate for gold of $20.67+ and for silver of $1.29. Commercial values have been figured at a rate of 52 cents per fine ounce.
²Includes Alabama, Georgia, Maryland, North Carolina, South Carolina, Tennessee, and Virginia.
³Includes Arizona, Arkansas, Colorado, Idaho, Nevada, New Mexico, South Dakota, Utah, and Wyoming.
⁴Not reported; included with gold.

Comparison with smelter returns.—Argentiferous-lead and copper ores are reduced by smelting. There were only 3 lead smelters combined with silver-lead mines and constructed for the treatment of their own ores. Their total product for 1902 was equal to 137,002 ounces of silver and 1,884,591 pounds of lead, which was but a fraction of 1 per cent of the total product of silver-lead mines. The product of these smelters was shipped to eastern refineries. The bulk of the silver and lead produced reached the smelters and refineries either in crude state or after only a preliminary milling treatment. As shown further in Table 43, the former contained 26,270,578 ounces of silver and the latter 16,207,767 ounces, exclusive of 267,119 ounces which were produced by small mines and could not be classified. According to reports received by the Bureau of the Census from smelters and refineries, the production of refined silver in the United States in 1902 was made up as follows:

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1899, page 83.

	Fine ounces.
Produced by lead smelters and refineries	78,896,284
Produced by copper smelters and refineries	9,781,532
	88,677,816
Less contents of foreign ores reported	28,926,235
Total	59,751,581

The silver contents of foreign lead ores smelted on the Pacific coast were not reported, but the bullion product of those smelters is included in the above total. The ores imported through San Francisco, Cal., and Puget Sound, Wash., were valued at $2,519,289.[1] Figured at the rate of 52 cents per ounce of silver, they contained 4,844,786 ounces, which leaves 54,906,795 ounces of domestic silver. The total reported by private smelters and refineries to the Director of the Mint was 55,087,074 ounces.[2] Thus in all about 55,000,000 ounces of silver were produced by private smelters and refineries, of which over 44,000,000 ounces were produced from domestic ores by lead smelters and refineries. The last quantity covers the contents of all silver bearing ores, which shows the close interdependence between silver mining and lead smelting. The total silver product of 1902 was accordingly distributed by character of ore, as follows:

	Value.	Per cent.
Total value	$28,468,004	100.0
From gold and silver ores and placer bullion	[1]6,082,979	21.3
From argentiferous lead ores	15,385,872	54.1
From argentiferous iron ores	883,987	3.1
From copper ores	6,115,166	21.5

[1] Includes product of old dumps and tailings.

The total lead contents of argentiferous ores mined in 1902, including copper ores, amounted to 411,590,504 pounds. The refined lead product reported to the Bureau of the Census by lead smelters and refineries was 475,588,419 pounds, which included the production of foreign ores smelted on the Pacific coast and not segregated in the reports from smelters. The imports of lead in ore and base bullion at Puget Sound and San Francisco were reported as 27,969,934 pounds,[3] which must be deducted from the total reported by the smelters; this leaves 447,618,485 pounds of lead.

A portion of this quantity was produced from nonargentiferous lead; the United States Geological Survey estimates the quantity of soft lead refined by desilverizers at 5,395 tons, which leaves 436,828,485 pounds of argentiferous lead. The excess over the contents of ores mined equals 25,237,981 pounds, or 12,619 short tons. During 1902 the stock of domestic lead was reduced by 42,138 tons;[4] it is probable that the excess of the smelter returns represents the product of ores mined during the previous year. The United States Geological Survey estimates the yield of lead from argentiferous ores for 1902 at 195,571 tons.[5] This is 5 per cent short of the product reported by mine operators; the difference is easily accounted for by losses in smelting.

SHIPPING AND MILLING ORES.

The product after leaving the mine is treated either at a mill connected with the mine or at a custom mill in the vicinity; or it is merely concentrated at the mine and the dressed ore shipped to a smelter; or it is shipped in the crude state. Table 43 shows the tonnage, bullion contents, and gross value, total and per ton, of all ore sold and treated, classified according to the method of handling the same. No information of this character being available for certain small operators, from whom no individual reports were received, their estimated product is not included in Table 43.

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1902, page 314.

[2] Ibid., page 13.

[3] Commerce and Navigation of the United States, 1902, Vol. 1, page 386.

[4] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 211 and 212.

[5] Ibid., page 207.

TABLE 43.—TONNAGE TREATED AND BULLION CONTENTS OF ORES REDUCED AT MINE AND SHIPPED IN CRUDE STATE: 1902.

	Tons sold or treated.	GOLD.			SILVER.			
		Quantity.	Value.		Quantity.		Value.	
		Fine ounces.	Total.	Per fine ounce.	Total, fine ounces.	Per ton fine ounces.	Total.	Per fine ounce.
Aggregate	9,788,124	2,874,446	$58,122,187	$20.22	42,478,345	4	$21,315,793	$0.50
Mines and mills	8,232,753	1,815,482	36,924,616	20.34	22,317,525	3	11,175,262	0.50
Ore treated	7,978,906	1,666,515	34,062,535	20.44	16,207,767	2	8,153,607	0.50
Ore shipped	253,847	148,967	2,862,081	19.21	6,109,758	32	3,021,655	0.49
Mines without mill connection	1,555,371	1,058,964	21,197,571	20.02	20,160,820	13	10,140,531	0.50
Shipping ore	1,304,503	881,018	17,613,417	19.99	19,100,326	15	9,614,445	0.50
Milling ore	212,492	156,091	3,163,112	20.26	846,858	4	421,791	0.50
Concentrated ore	38,376	21,855	421,042	19.27	213,636	6	104,295	0.49

	LEAD.				COPPER.			Other metals—value.	Gross value—total.	Per cent.	Average gross value per ton.
	Quantity.		Value.	Cents per fine pound.	Fine pounds.	Value.	Cents per fine pound.				
	Total, fine pounds.	Per ton, per cent.									
Aggregate	409,734,484	2.09	$12,259,105	3.0	14,028,323	$1,016,114	7.2	$541,041	$93,254,240	100.0	$10.00
Mines and mills	322,708,401	1.96	10,109,749	3.1	7,559,660	507,790	6.7	309,962	59,027,379	63.3	7.00
Ore treated	259,346,816	1.62	8,387,860	3.2	4,475,952	341,581	7.6	309,962	51,252,545	55.0	6.00
Ore shipped	63,361,585	12.48	1,721,889	2.7	3,083,708	166,209	5.4	....	7,774,834	8.3	31.00
Mines without mill connection	87,026,083	2.80	2,149,356	2.5	6,468,663	508,324	7.9	231,079	34,226,861	36.7	22.00
Shipping ore	83,923,765	3.22	2,087,461	2.5	6,216,589	494,441	8.0	198,881	30,008,645	32.2	23.00
Milling ore	1,778,878	0.42	39,065	2.2	54,117	4,009	7.4	28,030	3,656,007	3.9	17.00
Concentrated ore	1,323,440	1.72	22,830	1.7	197,957	9,874	5.0	4,168	562,209	0.6	15.00

The preceding table brings out the economic reasons governing the method of handling the ore. Where there was a mill at the mine the average value of the ore was about $7 per ton; where there was no mill at the mine the average value was $22. In the absence of a mill at the mine only ore of a higher grade was mined. On the other hand, where the ore could be reduced at the mine, low-grade ore was advantageously mined and treated. Even where there was a mill at the mine a portion of the ore was shipped to smelters. The value of such ore in 1902 averaged about $30 per ton, whereas the average grade of the ore treated at the mine was $6 per ton. Where there was no mill belonging to the mine the bulk of the ore was shipped, the value of the average grade of shipping ore being $23 per ton. In some districts the proximity of custom mills permitted the treatment of ores averaging about $17 per ton.

Another consideration which determines the method of handling the ore was the nature of its metallic contents. Ore shipped in crude state from mines without mill connection contained considerable values in silver, viz. $9,614,445, averaging 15 ounces per ton, whereas ores treated at neighboring custom mills were valued chiefly for their gold contents, silver averaging only 2 ounces per ton. Lead was also an important element in shipping ores, averaging 3.22 per cent of the ore, whereas in milling ores it was only a fraction of 1 per cent.

At mines with mill connection the value of the ores treated was nearly all in their gold contents, silver averaging 2 ounces per ton and lead only about 1.62 per cent. The ores shipped contained a greater value in silver than in gold, the average tenor in silver being 32 ounces per ton. The lead contents were also valuable, averaging 12.48 per cent of the crude ore. In such cases the ores were sorted before treatment: ore rich in silver and lead was shipped to smelters, the rest being treated at the mine.

A portion of the ore treated at the mills was merely concentrated preparatory to shipping. This was notably the case with ores rich in lead. The product of the mills contained 259,346,816 pounds of lead, which had to be extracted by smelting.

The total quantity of ore concentrated was, according to reports, 1,820,589 tons; but much more was probably concentrated, as the reports on this subject are incomplete. All this ore was concentrated at plants belonging to the mines. Only 38,376 tons were concentrated for outsiders, they being producers whose mines were located in the neighborhood of concentrating plants.

Concentration of ores before shipping is one of the modern devices for the economical handling of ores. The quantity of concentrates produced was 206,330 tons; the quantity of crude ore treated to produce these concentrates was 1,820,589 tons, as stated; the average degree of concentration was accordingly 1 ton of concentrates to 9 tons of crude ore. This reduces the bulk of the ore to be shipped to one-ninth of its original weight; a large saving is thus effected in freight and treatment charges.

The prices which were paid for the metallic contents of the mining product varied in accordance with the condition in which it was marketed. Gold bullion, produced by amalgamating, cyaniding, and chlorination works connected with mines, sold at $20.44 per fine ounce; when the ore was reduced at custom mills, gold brought on an average $20.26 per ounce. Gold in ore brought from $19.21 to $19.99 per ounce. Silver was figured at 50 cents per ounce; a portion brought only 49 cents per ounce. Lead was disposed of at an average of 3 cents per fine pound; when sold as concentrates it averaged 3.2 cents per pound, while in the crude state it brought from five-tenths to 1 cent less. Copper brought from 5 to 8 cents per pound.

Charges for treatment and freight.—Charges for treatment and freight are governing factors in the working of mines. They are materially reduced when the ore is treated at the mine or concentrated. The total charges for treatment and freight reported from mines without a mill connection amounted to $11,050,789, of which $5,020,233 was treatment charges, $2,021,828 freight, and $4,008,728 could not be segregated, the charges and freight not being entered separately on the books of the operators. The total amount of treatment and freight charges reported from mines with mill connection was $10,277,686, of which $3,697,138 was treatment charges, $2,341,765 freight, and $4,238,783 could not be segregated.

The following table shows the treatment charges and freight, classified according to the method of handling the ore:

TABLE 44.—*Treatment charges and freight on the product of mines and mills: 1902.*

	Tons.	Gross value.	Treatment charges, including freight.	Average per ton	Value at mine.
Total	9,788,124	$93,254,240	$21,328,475	$2.18	$71,925,765
Mines and mills, ores sold and treated	8,232,753	59,027,379	10,277,686	1.25	48,749,693
Mines without mill connection	1,555,371	34,226,861	11,050,789	7.10	23,176,072
Shipping ore	1,304,503	30,008,645	9,865,405	7.56	20,143,240
Milling ore	212,492	3,656,007	1,039,533	4.89	2,616,474
Concentrated ore	38,376	562,209	145,851	3.80	416,358

The greater part of the treatment and freight charges on the product of mills consisted of deductions on concentrates and on 253,847 tons of ore shipped in crude state (see Table 43). The refining charges on bullion may be estimated at 1 per cent of the value of the gold contents and at 4 cents per ounce of silver, which is the highest rate charged by the United States mints and assay offices. This rate makes a total of $369,246 on gold and $892,751 on silver—in all, $1,261,997, or, in round figures, about $1,200,000. This leaves somewhat over $9,000,000 for treatment and for freight on concentrates and crude ore.

The amount of freight varied for the several states and within the same state materially, according to the location of the mine. The treatment and freight charges set the limit to the working of certain grades of ore. Table 45 shows, by states and territories, the total tonnage of ores treated at outside reduction works, the total treatment charges, including freight, and the average per ton, and the highest and lowest freight rate per ton. The freight charges indicate the distances of the mines from railroad connections.

TABLE 45.—*Tonnage treated at outside works, treatment charges, and freight, by states and territories: 1902.*

STATE OR TERRITORY.	Total tons treated at outside works	TREATMENT CHARGES, INCLUDING FREIGHT.		FREIGHT PER TON.			
				Shipping ores.		Milling ores	
		Total.	Average per ton	Highest	Lowest.	Highest.	Lowest.
United States	1,782,554	$13,167,148	$7.39	$50.00	$0.05	$18.00	$0.15
Arizona	9,120	132,041	14.48	50.00	1.00	1.25	0.75
California	22,415	91,656	4.09	36.00	0.20	15.00	0.30
Colorado	1,265,262	8,099,797	6.40	21.45	0.05	9.75	0.90
Idaho	11,893	229,663	19.31	40.00	2.00	13.04	0.50
Montana	56,806	628,273	11.06	11.00	0.50	3.75	0.39
Nevada	40,613	571,528	14.07	30.00	1.00	10.00	0.20
New Mexico	8,969	73,707	8.22	16.00	0.83	18.00	0.50
Oregon	1,174	5,212	4.44	12.00	3.65	2.50	0.15
South Dakota	115,202	310,340	2.69	15.00	0.30	2.25	0.75
Utah	219,817	2,822,665	12.84	23.70	0.70		
Washington	8,869	82,275	9.28	10.00	1.00		
All other states[1]	22,374	121,191	5.42				

[1] Includes mines located in Alabama, Arkansas, Georgia, North Carolina, South Carolina, Texas, Virginia, and Wyoming.

The freight rates were higher on shipping ores than on milling ores; the highest freight from the mine to the mill, $18 per ton, was paid in New Mexico; the highest freight from the mine to the smelter, $50 per ton, was paid in Arizona.

Grade of ore.—In Table 46 the gold and silver contents of all ores mined in 1902, wherein the precious metals were the chief item of value, are classified by the grade of ore. There were a number of cases which did not lend themselves to such a classification. In many mines the ore is sorted, first-class ore being shipped and second-class ore being treated at the mine. Census schedules did not call for a separate statement for each class of ore, and an average for all grades would fail for the purpose of this classification. However, as eight-ninths of the total gold product of deep mines and four-fifths of the total silver product have been classified, the table answers the purpose.

TABLE 46.—GOLD AND SILVER VALUES CONTAINED IN THE PRODUCT OF PRECIOUS METAL MINES, CLASSIFIED BY GRADE OF ORE, BY STATES AND TERRITORIES: 1902.

VALUE PER TON.	GOLD, TOTAL VALUE.								
	United States.	Arizona.	California.	Colorado.	Montana.	Nevada.	South Dakota.	Utah.	All other states and territories.[1]
All grades	$51,260,480	$2,130,996	$10,737,262	$23,281,795	$2,843,618	$1,658,790	$6,341,429	$2,928,816	$2,158,067
Less than $10	21,199,278	1,111,418	6,870,510	2,850,590	976,113	108,425	6,185,198	2,367,292	1,225,074
$10 and over, but less than $20	9,254,094	650,220	2,197,654	4,279,398	817,116	283,968	144,396	401,865	429,857
$20 and over, but less than $50	17,904,150	252,980	1,405,758	13,741,412	702,851	811,874	10,025	156,011	384,639
$50 and over, but less than $100	2,177,120	51,103	102,983	2,041,776	119,389	72,069	1,800	3,648	87,291
$100 and over	1,436,458	65,275	153,317	368,619	228,150	419,892			33,106

VALUE PER TON.	SILVER, TOTAL VALUE.						RECAPITULATION, UNITED STATES.	
	United States.	Colorado.	Montana.	Nevada.	Utah.	All other states and territories.[2]	Gold, per cent.	Silver, per cent.
All grades	$17,321,192	$6,347,543	$1,837,217	$1,728,319	$4,523,240	$2,084,533	100.0	100.0
Less than $10	4,311,369	1,896,767	861,190	45,838	221,085	1,326,649	41.4	25.1
$10 and over, but less than $20	6,181,826	1,781,700	331,120	291,164	3,429,920	347,952	18.0	35.7
$20 and over, but less than $50	3,518,381	2,142,660	240,078	132,406	192,515	190,761	35.2	20.3
$50 and over, but less than $100	1,824,000	411,867	306,253	35,210	616,712	153,987	4.3	10.5
$100 and over	1,462,613	114,549	58,780	1,223,801		65,184	2.6	8.4

[1] Includes mines located in Alabama, Arkansas, Georgia, Idaho, New Mexico, North Carolina, Oregon, South Carolina, Virginia, Washington, and Wyoming.
[2] Includes mines located in Alabama, Arizona, California, Georgia, Idaho, New Mexico, North Carolina, Oregon, South Carolina, South Dakota, Texas, Virginia, and Washington.

It appears from the preceding table that little gold was produced in 1902 from ores worth over $50 per ton. About two-fifths of all gold produced was won from low-grade ores worth less than $10 per ton, and about the same share was obtained from ores worth $20 or over.

Considering the three principal gold producing states, Colorado, California, and South Dakota, and taking $20 per ton as the dividing line between high-grade ores and average or low-grade ores, it appears that in Colorado high-grade ores predominate, whereas in California and South Dakota the product was chiefly won from low-grade ores. In South Dakota practically all gold was derived from ores worth less than $10 per ton. Of the smaller gold producers, Utah also treated mostly low-grade ores.

Silver was likewise won mostly from ores averaging less than $20 per ton, but the lowest grade of ore, averaging less than $10 per ton, was not as conspicuous as in gold mining. A comparative study of Tables 45 and 46 will show the extent to which the distance of the mine from reduction works affects the grade of ore treated. In Arizona the highest cost of freight for shipping ore was $50 per ton. Very little gold, however, was produced from ores which could bear such a freight rate. In California the highest freight rate on shipping ores was $36 per ton, while two-thirds of all gold was derived from ores worth less than $10 per ton, and less than one-sixth was produced from ores worth from $20 to $50 and over. In South Dakota the highest freight rate on shipping ore was $15 per ton, but the bulk of the ore was worth less than $10 per ton, and the quantity of high-grade ore, which could bear the highest freight rate, was insignificant.

An examination of the average treatment charges, inclusive of freight, will show what portion of the gold and silver ores produced in each state must be treated at or near the mine and what portion can be shipped to distant works. Taking the United States as a whole, it appears that two-fifths of all gold and one-fourth of all silver are recovered from ores worth less than $10 per ton, which could hardly bear the average transportation charges of $7.39 per ton and can therefore be economically treated only at or near the mine. On the other hand, about two-fifths of all gold and silver are won from ores worth over $20 per ton, which could be profitably shipped to distant works for treatment.

The following comparative table shows the average grades of gold and silver ore mined in 1880 and 1902. The Tenth Census took no cognizance of the base metallic contents of gold and silver ores. To make the data of both censuses comparable the gold and silver contents only are considered in the table which follows:

Table 47.—TONS OF ORE TREATED, GOLD AND SILVER CONTENTS, TOTAL AND AVERAGE PER TON, BY STATES AND TERRITORIES, 1902 AND 1880.

STATE OR TERRITORY	1902							
	Tons of ore treated	Gold		Silver			Total value	
		Fine ounces	Value	Fine ounces	Value		Coining	Commercial
					Coining	Commercial		
United States	9,787,803	2,889,385	$59,741,290	42,741,761	$55,261,678	$21,146,616	$115,002,968	$81,157,906
Arizona	341,269	115,059	2,378,336	1,044,181	1,350,043	524,894	3,728,379	2,903,230
California	2,325,100	570,623	11,795,824	380,189	491,554	191,329	12,287,378	11,987,153
Colorado	2,230,589	1,318,048	27,246,366	13,531,846	17,495,601	6,846,379	44,741,967	34,092,745
Idaho	1,283,777	55,763	1,152,724	7,091,436	9,168,659	3,564,613	10,321,383	4,717,337
Montana	542,029	146,086	3,020,010	3,766,220	4,869,421	1,898,838	7,889,431	4,918,848
Nevada	238,607	85,821	1,774,077	3,781,009	4,888,569	1,882,703	6,662,646	3,656,780
New Mexico	39,265	11,595	239,690	276,269	357,194	142,825	596,884	382,515
Oregon	60,064	63,610	1,314,935	112,654	145,653	57,910	1,460,588	1,372,845
South Dakota	1,086,187	351,308	7,262,181	535,041	691,765	278,725	7,953,946	7,540,906
Utah	897,866	146,687	3,032,289	11,406,273	14,747,399	5,666,160	17,779,688	8,698,449
All other states[1]	143,073	25,390	524,858	816,625	1,055,830	392,252	1,580,688	917,110

STATE OR TERRITORY	1880								1902		1880	
	Tons of ore treated.	Gold.		Silver.[2]			Total value.		Average value per ton.		Average value per ton.	
		Fine ounces.	Value.	Fine ounces	Value		Coining.	Commercial.	Coining	Commercial	Coining	Commercial.
					Coining	Commercial.						
United States	1,884,426	972,588	$20,105,077	30,577,025	$39,533,033	$34,674,342	$59,638,110	$54,779,419	$11.75	$8.29	$31.65	$29.07
Arizona	25,728	8,725	180,366	1,716,178	2,218,844	1,946,144	2,399,210	2,126,510	10.93	8.51	93.25	82.65
California	435,300	402,470	8,319,786	828,580	1,071,215	939,560	9,391,001	9,259,346	5.28	5.16	21.57	21.27
Colorado	330,581	110,181	2,277,649	12,579,551	16,264,101	14,265,211	18,541,750	16,542,860	20.06	15.28	56.09	50.04
Idaho	28,030	28,690	593,073	344,969	446,010	391,195	1,039,083	984,268	8.04	3.67	37.07	35.11
Montana	86,577	30,570	631,946	2,177,760	2,815,627	2,469,580	3,447,573	3,101,526	14.56	9.07	39.82	35.82
Nevada	346,331	206,907	4,277,156	8,964,462	11,590,282	10,165,813	15,867,438	14,442,969	27.92	15.33	45.82	41.70
New Mexico	7,452	2,388	49,354	303,455	392,337	344,118	441,691	393,472	15.20	9.74	59.27	52.80
Oregon	13,772	8,296	171,276	13,880	17,946	15,740	189,222	187,016	24.33	22.87	13.74	13.58
South Dakota[3]	496,130	151,837	3,138,751	54,577	70,563	61,890	3,209,314	3,200,641	7.32	6.94	6.47	6.45
Utah	93,117	13,063	270,045	3,555,538	4,596,954	4,031,980	4,866,999	4,302,025	19.80	9.69	52.27	46.20
All other states[1]	21,408	9,466	195,671	38,021	49,158	43,116	244,829	238,787	11.05	6.41	11.44	11.15

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[1] Includes Alabama, Arkansas, Georgia, Maryland, North Carolina, South Carolina, Tennessee, Texas, Virginia, Washington, Wyoming, Maine, New Hampshire, and Michigan.

[2] The commercial value of an ounce of silver for the census year 1880 was obtained by taking the average between the prices for 1879 and 1880, which is $1.134.

[3] In 1880 formed part of the territory of Dakota.

As appears from Table 47, in all states and territories, except Oregon, the grade of ore has considerably decreased, while at the same time the quantity of ore mined and the total gold and silver values show everywhere a remarkable increase. This fact furnishes unmistakable evidence of the progress of gold and silver mining since the Tenth Census. The development of transportation facilities and improvement of mining methods and reduction processes have enabled the mine operators to handle large masses of low-grade ore which could not have been profitably mined two decades ago.

Classification of mines by metals produced.—In Table 48 all deep mines are classified into two groups—(1) gold and silver mines and (2) argentiferous lead mines. The ore mined from the former is valued chiefly for its gold contents, though it carries considerable values in silver and small quantities of other metals. The mines of the latter class yield lead ores rich in silver and associated with gold and other metals.

The total gold contents of the ores of both classes were valued at $57,829,542, of which $5,734,677, or about one-tenth, was carried by argentiferous lead ores and $52,094,865 by gold and silver ores. The latter can again be divided into two portions: about one-half, valued at $26,898,810, carried considerable values in silver, the rest, valued at $25,136,100, was produced from mines which reported no value for silver. It is probable that in many cases this gold was likewise associated with silver, but the percentage of silver saved was too small to be of commercial value.

The silver-lead mines include also those which reported no values other than those for silver. The total product of such mines was valued at $430,281. It is probable, however, that some of this silver was associated with lead, but the percentage of the latter was below the 5 per cent limit paid for by the smelters.

The value of the product shown in Table 48 is only that of the ore actually sold or treated. Ore mined but not sold or treated is not taken into consideration for the following reason: Gold and silver ores are mostly reduced at mills connected with the mines. It will be remembered that in such cases the value of the increase or decrease of the stock of ore was not estimated. Argentiferous lead ores, on the contrary, are all shipped to smelters, so that the value of the increase or decrease of the stock was oftener estimated for this class of ore than for gold and silver ores. In order to avoid artificial disproportion in the results obtained, the total value of the product at the mine includes only the value of the ore sold or treated and the amount received from custom work, less the cost of purchased materials.

TABLE 48.—*Summary of deep mines, classified by metals produced: 1902.*

	Total	Gold and silver.	Argentiferous lead
Number of mines[1]	1,935	1,488	447
Salaries	$4,569,392	$3,270,427	$1,298,965
Wages	$33,582,274	$24,653,242	$8,929,032
Contract work	$606,137	$440,993	$165,144
Work on share of product	$1,375,843	$1,348,059	$27,784
Miscellaneous expenses	$4,779,249	$3,683,066	$1,096,183
Cost of supplies and materials	$15,096,534	$11,796,089	$3,300,445
Cost of purchased ores, including freight	$13,789	$13,789	....
Ore sold and treated, short tons	9,662,050	7,052,236	2,609,814
Ore purchased, short tons	967	967	..
Value of bullion contents:			
Gold	$57,829,542	$52,094,865	$5,734,677
Silver	$21,215,701	$5,829,829	$15,385,872
Lead	$12,258,530	....	$12,258,530
Other metals	$1,552,058	$448,272	$1,103,786
Total gross value	$92,855,831	$58,372,966	$34,482,865
Average per ton	$10	$8	$13
Treatment charges and freight	$21,271,711	$10,027,089	$11,244,622
Value of product at mine	$71,584,120	$48,345,877	$23,238,243
Amount received for custom work	$529,030	$487,937	$41,093
Total value at mine	$72,098,361	$48,819,025	$23,279,336
Average per mine	$37,260	$32,809	$52,079

[1] Does not include 55 custom mills and 27 mills run on old dumps and tailings.

The following table presents a classification of all dividend paying productive deep mines by metals produced:

TABLE 49.—*Dividend paying productive deep mines, classified by metals produced: 1902.*

	Total.	Gold and silver	Argentiferous lead
Number of mines[1]	100	71	29
Salaries	$1,358,783	$857,821	$500,962
Wages	$10,096,917	$6,707,061	$3,389,856
Contract work	$165,135	$105,793	$59,342
Work on share of product	$202,754	$194,754	$8,000
Miscellaneous expenses	$1,747,144	$1,040,099	$707,045
Cost of supplies and materials	$4,730,536	$3,572,962	$1,157,574
Ore sold and treated, short tons	3,163,498	2,039,925	1,123,573
Value of bullion contents:			
Gold	$24,382,754	$22,560,052	$1,822,702
Silver	$11,066,762	$2,469,000	$8,597,762
Lead	$6,849,001		$6,849,001
Other metals	$561,171	$89,997	$471,174
Total gross value	$42,859,688	$25,119,049	$17,740,639
Average per ton	$13.55	$12.31	$15.79
Treatment charges and freight	$9,514,541	$3,840,162	$5,674,379
Value at mine	$33,345,147	$21,278,887	$12,066,260
Amount received for custom work	$58,638	$58,638	
Total value of product at mine	$33,403,785	$21,337,525	$12,066,260
Average per mine	$334,038	$300,529	$416,078

[1] Does not include 2 mills run on old dumps and tailings.

DEEP MINES.

Mines with and without reduction works.—The majority of deep mines had no reduction works to treat their ores; about one-third of the total number were equipped with reduction works. The latter, however, contributed about two-thirds of the product of gold and silver mines. The average production of a mine which had no mill was $18,178, whereas the average for the 585 mines equipped with reduction works was $86,381. The average grade of ore treated by the former was worth $22, whereas the latter treated low-grade ore worth less than $10 per ton, viz, 316 mills treated ore averaging $8.65 per ton and 269 treated ore averaging $5.43 per ton. About one-half of the mines connected with mills furnished separate reports for the mine and the mill. A number of operators, however, kept only one account for both mine and mill, and so reported them.

The following table is a comparative summary of mines with and without reduction works; mines and mills for which distinct reports were furnished are presented under a separate head:

TABLE 50.—*Deep mines with and without mill connection: 1902.*

	Deep mines without mill connection.	Mines and mills reported jointly	MINES AND MILLS REPORTED SEPARATELY.	
			Mines	Mills
Number of mines[1]	1,275	316	269	....
Salaried officials, clerks, etc.:				
Number	1,198	887	763	226
Salaries	$1,557,468	$1,441,066	$1,262,685	$506,978
Wage earners:				
Average number	10,485	9,969	10,648	1,867
Total wages	$10,779,143	$10,155,216	$10,672,006	$1,951,155
Contract work	$387,117	$98,518	$120,502	......
Work on share of product	$1,239,379	$80,504	$53,790	......
Miscellaneous expenses	$1,922,388	$1,644,418	$1,028,176	$181,283
Cost of supplies and materials	$8,475,604	$4,071,787	$4,486,299	$2,050,097
Crude ore shipped, short tons	[2]1,555,371	253,847	....	....
Ore treated, total, short tons	....	2,544,142	....	5,368,143
Mined and treated	....	2,500,282	....	5,348,806
Purchased ores	....	43,860	....	967
Custom ores	....	......	....	18,370
Value of bullion contents:				
Crude ore shipped—				
Gold	$21,197,571	$2,862,081	......	......
Silver	$10,140,531	$3,021,655	......	......
Lead	....	$1,721,889	......	......
Other metals	$2,888,759	$166,209	....	....
Total gross value	$34,226,861	$7,771,834	....	....
Average per ton	$22	$31	....	....
Treatment charges and freight	$11,050,789	$2,915,660	......	......
Value at mine	$23,176,072	$4,856,174	......	......
Ore treated—				
Gold	....	$14,158,166	....	$19,485,002
Silver	....	$3,686,212	....	$4,366,205
Lead	....	$3,519,700	....	$4,864,585
Other metals	....	$270,624	....	$375,822
Total gross value	....	$21,634,702	....	$29,091,614
Average per ton	....	$9	....	$5
Treatment charges and freight	....	$3,387,791	....	$3,820,678
Value at mine	....	$18,246,911	....	$25,270,936
Amount received for custom work	......	[3]$402,206	..	$42,740
Cost of purchased ores, including freight	....	....	....	$13,789
Total value of product at mine	....	$23,505,291	....	$25,299,887
Average per mine	$18,178	$74,387	....	$94,052

[1] Does not include 48 arrastras, nor 27 mines whose product was reduced in hand mortars.

[2] Includes ore treated at custom mills.

[3] Includes $254,797 charged by reduction works against their own mines and credited by the latter to their reduction works.

Arrastras.—The primitive Mexican arrastra, in its old-fashioned form or somewhat modernized, has survived in a few small mines. The total number of mines reporting arrastras was 47, viz, 36 in California, 6 in Oregon, 3 in Idaho, 1 in Arizona, and 1 in New Mexico. At 23 no hired labor was employed.

The total value of the product of all such mines was $77,818, the average per mine being $1,655. The average tonnage treated was 75 tons per mine. A summary of mines with arrastras is presented in the following table:

TABLE 51.—*Summary for arrastras: 1902.*

Number of mines	47
Number of owners working	57
Salaries	$250
Wages	$16,388
Work on share of product	$2,170
Miscellaneous expenses	$956
Cost of supplies and materials	$5,228
Ore treated, short tons	3,632
Value of bullion contents:	
Gold	$78,798
Silver	$1,086
Total gross value	$79,884
Average per ton	$22
Treatment charges and freight	$1,566
Value at mine	$77,818
Average per mine	$1,655

Ore treated by hand.—Even the crudest form of treatment of ore in a hand mortar was found in a few cases. As a survival of archaic methods of production these mines well deserve notice. The 28 mines at which the ore was treated in such manner were distributed among the following states: California, 19; Oregon, 8; and Maryland, 1. The total output of these mines aggregated $48,280, averaging $1,724 per mine. There were 36 owners working in the mines, only 6 of which were operated with hired labor. The average quantity thus treated was less than 9 tons per mine, but the average value per ton was $200. There was evidently no regular production, but in every case a rich strike had been found by men of small means, who had no other facilities for treating their ore. A summary of these mines is presented in the following table:

TABLE 52.—*Summary for mines where the ore was treated in hand mortars: 1902.*

Number of mines	28
Number of owners working	36
Salaries	$986
Wages	$8,367
Miscellaneous expenses	$1,728
Cost of supplies and materials	$3,519
Ore treated, short tons	242
Bullion contents—	
Quantity—	
Gold, fine ounces	2,343
Silver, fine ounces	23
Value—	
Gold	$48,424
Silver	$12
Total gross value	$48,436
Average per ton	$200
Value of product at mine	$48,280
Average per mine	$1,724

Custom mills.—The following is a summary for mills which were operated independently of mines on purchased or custom materials. It comprises 24 mills in Colorado, 10 in California, 9 in Nevada, 4 in Idaho, 3 in New Mexico, and 1 each in Arizona, Montana, Oregon, South Dakota, and Utah.

TABLE 53.—*Summary for custom mills: 1902.*

Number of mills	55
Salaried officials, clerks, etc.:	
Number	68
Salaries	$141,126
Wage earners:	
Average number	684
Wages	$578,101
Miscellaneous expenses	$254,980
Cost of supplies and materials	$723,807
Cost of purchased ore	$5,951,048
Freight on purchased ore	$411,504
Ore treated, short tons	
Total	533,730
Purchased ore	352,316
Custom ore	181,414
Value of bullion contents of purchased ore.	
Gold	$8,332,350
Silver	$102,029
Total gross value	$8,434,379
Average per ton	$24
Treatment charges and freight	$23,525
Value of product at mill	$8,410,854
Amount received for custom work	$289,205
Total value at mill	$8,700,059
Average per mill	$158,183

Among the 55 mills comprised in the preceding summary there were 7 which were operated without hired labor; the number of owners personally working in their mills was 15. The time in operation was reported by 45 custom mills; the data furnished by them are included in Tables 17, 18, and 20. Of this number, 12 ran more than three hundred days during the year and 7 from two hundred and seventy-one to three hundred days; these 19 mills may be taken as representing all that were in continuous operation throughout the year, except on holidays and when stoppages were necessary for repairs, etc. Of the other 26 mills, operated only part of the year, 11 ran from ninety-one to two hundred and seventy days and 15, ninety days or less; that is, only during the busiest season.

The majority, when working, ran more than one shift, viz: 25 ran two shifts and 7 three shifts, while 13 ran only one shift. When two or three shifts were run the mill was operated uninterruptedly during twenty-four hours, making either twelve or eight hours per shift, except in 2 mills, where two shifts of eight hours each were run. Of the 13 mills running only one shift 7 were working twelve hours per day, 5 ten hours, and 1 eight hours. On the whole, twelve hours per shift was the working time in 30 mills, ten hours in 5 mills, and eight hours in 10 mills.

The total capacity of all custom mills per twenty-four hours was 2,892 tons. Two mills which treated during the year 350 tons failed to report their daily capacity. The total tonnage treated by all mills reporting their capacity was 533,380 tons. It required accordingly 184 days of twenty-four hours to handle that quantity of ore. This fact shows that the mines provided a sufficient supply of ore to keep the custom mills in continuous operation every day in the year with one working shift of twelve hours per day, including Sundays and holidays.

The total value at mill in Table 53 is $8,700,059. In computing the total value of the product shown in Table 35 for all mines and mills in the United States, the value of purchased materials was deducted in order to prevent duplications. The mills handled practically only gold ore of a high grade, averaging $24 per ton. About two-thirds of the ore treated at custom mills was purchased by them, and only about one-third was treated for customers at a stipulated rate per ton, the product being returned to the customers. Some custom work was occasionally done at mills connected with mines; it was only as an exception, however, that ore was purchased at such mills. In the statement which follows, the quantities of ore purchased and treated for a stipulated compensation per ton are summarized for all mills, those connected with mines as well as custom mills:

Tons of ore bought and treated for a stipulated compensation: 1902.

CHARACTER OF REDUCTION WORKS.	Purchased ore.	Custom work.
Total	353,283	243,644
Custom mill	352,316	181,414
Connected with mine	967	62,230

The reports from mines whose ore was treated at custom mills show 212,492 tons reduced to bullion and 38,376 tons concentrated and shipped to smelters for reduction; in all, 250,868 tons. The mine operators reported 7,224 tons, or 2.9 per cent more than was traced to mills.

There are many reasons why the returns from establishments representing successive stages of production can not exactly coincide. Among other things, the census was taken in the spring and summer of 1903 for the calendar year 1902. Some of the mills which had been in operation a few months in the early part of the year 1902 were idle or dismantled at the time the census was taken and their owners could not be located. Still, the preceding comparison shows that the omission was not material.

Mills in 1902 and 1880.—The following statement presents the comparative data relating to mills for 1902 and 1880. Making allowance for the incompleteness of the Tenth Census, the statement shows a remarkable increase both in the number of reduction works and the total quantity of ore treated by them. The average turnover per mill has also increased.

Production of mills, 1902 and 1880.

YEAR.	Number of mills.	TONS TREATED.	
		Total.	Average per mill.
1902	640	8,444,967	13,195
1880	169	1,467,579	8,684

METHODS OF TREATING THE ORE.

Of the 585 reduction works connected with deep mines, 456 were stamp mills, in which the ore was reduced by amalgamation; 83 were equipped with cyaniding plants, 16 with chlorination plants, and 301 with concentrators. Of the 55 custom mills, 46 were stamp and amalgamation mills, 10 were equipped with cyaniding, 5 with chlorination, and 21 with concentrating plants. There were, moreover, 27 mills which were run mainly on old mine dumps and mill tailings, though occasionally doing custom work. Of these, 16 were cyaniding works, 4 were stamp mills, and 7 were concentrating plants.

A difference in methods of transacting business among the various classes of custom mills deserves to be noted. Where the ore is treated by amalgamation, with or without concentration of the tailings, the mill operator, as a rule, does the work for the customer's account for a stated compensation and returns the product to the mine owner. At chlorination and cyaniding works, on the contrary, the ore is bought outright.

The relative place held by each class of mills in the gold and silver mining industry is shown by a comparison of the gross values of the ores treated by them. It should be noted that some cyaniding and chlorination works were also equipped with stamp mills and concentrating plants where a portion of the ore was treated.

Method of treating ore, by classes of mills: 1902.[1]

CHARACTER OF PROCESS.	Total.	Mills connected with mines.	Custom mills.
Total	$58,073,917	[illegible]	$8,444,579
Amalgamation	5,290,246	5,290,246	....
Concentration	14,248,871	14,248,871	....
Amalgamation and concentration	13,403,276	13,399,172	4,104
Cyaniding alone or in combination with other processes	16,598,667	15,674,687	923,980
Chlorination alone or in combination with other processes except cyaniding	9,842,857	2,330,568	7,512,289

[1] Exclusive of mills operating only on old dumps and tailings.

Amalgamation and concentration.—Table 54 is a summary for amalgamation mills and concentrating plants. Where the ore was treated only by amalgamation its chief value consisted in its gold contents, though considerable values in silver were also saved. The values shown for "other metals" were realized from the sale of the tailings. The average grade of ore treated was worth only $6 per ton. A small quantity of high-grade ore averaging $68 per ton was shipped in crude state.

Where the ore was merely concentrated its main value was in its base metal contents (practically all lead). The ore averaged in crude state for one group of mills $11 per ton, and for another $7, and had to be concentrated before it could be shipped. High-grade ore was sorted out before concentrating and shipped in crude state; such ore shipped from the same class of mills averaged $28 and $43 per ton, respectively.

Where amalgamation was supplemented by concentration the chief value was in gold. These mills from which complete reports were received showed some values for silver and base metals; where the accounts were not kept separately for the mine and mill the total value was reported as gold, though in all probability it included some silver and base metals.

There was also a marked difference in the volume of production according to the character of the process applied: The value of the average product per mine with stamp mill (amalgamation) was a little over $15,000; the average per mine with stamp mill and concentration plant was over $50,000, while mines in which the base metals predominated reported a much higher average production, valued at over $100,000.

The average production per custom mill represented its earnings for custom work. The operations of ordinary stamp mills were quite small, averaging $1,385 per mill. Where stamp mills were equipped with concentrating plants the operations were conducted on a somewhat larger scale, averaging $8,488 per mill. It must be borne in mind that these averages are not comparable with those for stamp mills connected with mines, since the value of the ore is not included in the former, as the custom mills bought no ore.

TABLE 54.—MINES AND MILLS, WITH AMALGAMATION AND CONCENTRATION PLANTS: 1902.

	AMALGAMATION ONLY.			CONCENTRATION ONLY.		AMALGAMATION AND CONCENTRATION.		
	Mines and mills reported jointly.	Mines and mills reported separately.	Custom mills.	Mines and mills reported jointly.	Mines and mills reported separately.	Mines and mills reported jointly.	Mines and mills reported separately.	Custom mills.
Number of operators	125	82	19	32	36	104	[illegible]	22
Salaries:								
Total	$228,687	$153,526	$3,277	$227,654	$495,908	$440,159	$450,301	$40,764
Mine		$126,417			$395,571		$327,908	
Mill		$27,109	$3,277		$100,337		$122,393	$40,764
Wages:								
Total	$1,378,433	$678,208	$5,774	$1,906,620	$3,240,350	$2,958,200	$2,450,690	$69,806
Mine		$546,796			$2,822,901		$1,896,357	
Mill		$131,412	$5,774		$417,449		$554,333	$69,806
Contract work:								
Total	$21,151	$24,509		$3,039	$39,221	$52,933	$78,167	
Mine	$21,151	$24,509		$3,039	$39,221	$52,933	$78,167	
Work on share of product:								
Total	$30,036				$37,390	$16,400		
Mine	$30,036				$37,390	$16,400		
Miscellaneous expenses:								
Total	$170,823	$52,301	$2,478	$501,698	$316,320	$342,694	$391,963	$39,505
Mine		$48,468			$294,878		$307,604	
Mill		$3,833	$2,478		$21,442		$84,359	$39,505
Cost of supplies and materials:								
Total	$565,546	$464,054	$6,225	$791,651	$1,331,443	$1,149,123	$1,093,392	$238,835
Mine		$272,122			$1,090,460		$769,748	
Mill		$191,932	$6,225		$240,983		$323,644	$238,835
Crude ore shipped:								
Short tons	467			82,771	52,677			
Value of bullion contents	$31,845			$2,326,899	$2,245,967			
Value at works	$25,698			$1,711,583	$1,385,376			
Average per ton	$68			$28	$43			
Quantity of materials treated, tons:								
Total	322,989	248,396	10,933	441,374	1,250,186	758,351	1,269,243	179,618
Ore from mine	315,317	246,327		441,374	1,244,717	750,679	1,259,412	
Custom ores	7,672	2,069	10,933		5,469	7,672	9,831	179,618
Value of bullion contents of ore treated:[1]								
Gold	$1,836,470	$958,599		$256,713	$1,642,979	$6,116,525	$6,310,596	[2]$1,100
Silver	$16,977	$408,041		$1,634,307	$2,540,560		$985,856	
Other metals	$6,108	$34,051		$3,134,096	$5,040,216		$689,199	
Total gross value	$1,859,555	$1,400,691		$5,025,116	$9,223,755	$6,116,525	$7,985,651	
Average per ton	$6	$6		$11	$7	$8	[illegible]	
Treatment charges and freight	$12,856	$31,685		$1,538,870	$3,176,546	$855,142	$750,034	$126
Value at works	$1,846,699	$1,369,006		$3,486,246	$6,047,209	$5,261,383	$7,235,617	$974
Amount received for custom work	$30,573	$6,750	$26,314		$11,360	$30,573	$19,738	$186,742
Total value at works	$1,877,272	$1,375,756	$26,314	$3,486,246	$6,058,569	$5,291,956	$7,255,355	$187,716
Average per mine or mill	$15,018	$16,777	$1,385	$108,945	$168,294	$50,884	$68,438	$8,533

[1] Exclusive of custom ores.

[2] Ore from abandoned mine.

Chlorination plants.—There were in all 22 chlorination plants, of which 4 were combined with cyaniding plants and are included with the latter in a subsequent table. Of the remaining 18 only 7 treated their ores exclusively by chlorination; in all others the ore was first treated by amalgamation and the tailings were then treated by chlorination. In 10 mills the chlorination process was preceded by concentration.

The following table is a summary of all mines and mills with chlorination plants:

TABLE 55.—MINES AND MILLS, WITH CHLORINATION PLANTS: 1902.

	Mine and mill reported jointly.	Mine and mill reported separately.	Custom mills.
Number of operators	7	7	4
Salaries:			
Total	$107,743	$185,920	$88,605
Mine		$153,903	
Mill		$32,017	$88,605
Wages:			
Total	$958,391	$1,725,411	$344,760
Mine		$1,509,213	
Mill		$216,198	$344,760
Contract work:			
Total	$1,455		
Mine	$1,455		
Miscellaneous expenses:			
Total	$115,154	$258,642	$204,298
Mine	$115,154	$227,211	
Mill		$31,431	$204,298
Supplies and materials:			
Total	$446,135	$841,216	$431,784
Mine		$527,178	
Mill		$314,038	$431,784
Cost of purchased ores		$6,934	$5,660,298
Crude ore shipped:			
Tons	100,356		
Value of bullion contents, total, gross	$2,515,532		
Average per ton	$25		
Value at mine	$1,599,614		

	Mine and mill reported jointly.	Mine and mill reported separately.	Custom mills.
Quantity of materials treated:			
Total, tons	98,621	399,817	309,027
Ore from mine	98,621	399,376	
Purchased ores		117	309,027
Custom ores		324	
Bullion contents of ores mined and treated:			
Gold—			
Ounces	14,228	57,756	363,778
Value	$293,743	$1,182,639	$7,519,299
Silver—			
Ounces	95,056	1,615,498	
Value	$47,538	$817,507	
Total value	$341,281	$2,000,146	$7,519,299
Average per ton	$3	$5	$24
Purchased ores:			
Value of bullion contents		$9,131	
Average per ton		$62	
Total gross value of product	$341,281	$2,009,277	$7,519,299
Charges for treatment and freight	$1,984	$66,750	$18,290
Value at works	$339,297	$1,942,527	$7,501,009
Amount received from custom work	[1]$254,797	$3,482	
Total value at works	$594,094	$1,946,009	$7,501,009
Average per mine or mill	$313,387	$278,001	$1,875,252

[1] Includes $254,747, amount earned for treating 68,000 tons of ore which are included in ore sold, as treatment charges could not be segregated.

Cyaniding plants.—An exhaustive treatment of the cyaniding process will be found in a special chapter following this report. Table 56 is a summary for cyaniding mills of all descriptions, including those running on old dumps and tailings. The first five columns of the table relate to cyaniding plants connected with mines and the last column to custom mills. The former are classified according to methods of treatment, under the following heads: (1) cyanide only, (2) cyanide with crushing, (3) cyanide with amalgamation, (4) cyanide with chlorination, and (5) miscellaneous. The last column includes all mills whose expenses were not separately reported, as well as those combined with smelters, for which separate reports were furnished. The number of custom mills was too small to permit of the same classification without disclosing the identity of some individual plants.

Table 56 contains an item of $908,156, representing the value of ore shipped to other works; one portion of this amount, viz, $495,403, represents the value of ore treated at other works owned by the same operators; the quantity of this ore was not separately reported, and is therefore included in the total quantity. In computing the average value per ton it was therefore necessary to add this value in the total value of bullion contents mined and treated; the amount thus added being about 3 per cent of the true value, the error in the average can not exceed 15 cents per ton, which is immaterial, cents being disregarded in the averages.

TABLE 56.—MINES AND MILLS, WITH CYANIDING PLANTS: 1902.

	Cyanide only.	Cyanide with crushing.	Cyanide with amalgamation.	Cyanide with chlorination.	Miscellaneous.	Custom mills.
Number of operators	7	10	9	3	54	26
Salaries:						
Total	$51,907	$69,718	$95,074	$29,910	$443,256	$48,377
Mine	$44,607	$62,403	$74,255	$26,310		
Mill	$7,300	$7,315	$20,819	$3,600		$48,377
Wages:						
Total	$681,932	$505,397	$2,340,261	$521,412	$3,105,152	$215,694
Mine	$451,208	$396,544	$2,057,356	$438,185		
Mill	$230,724	$108,853	$282,905	$83,227		$215,694
Contract work:						
Total			$4,250		$21,395	
Mine			$4,250		$21,395	
Miscellaneous expenses:						
Total	$30,284	$40,947	$115,119	$58,101	$465,027	$23,066
Mine	$28,784	$34,215	$78,972	$45,692	$465,027	
Mill	$1,500	$6,732	$36,147	$12,409		$23,066
Supplies and materials:						
Total	$560,297	$293,758	$1,583,271	$200,168	$1,343,997	$121,121
Mine	$302,066	$160,860	$964,109	$146,921	$1,343,997	
Mill	$258,231	$132,898	$619,162	$53,247		$121,121
Cost of purchased ores		$900			$2,003	$702,274
Crude ore shipped to other works, value at mine	$76,487		$13,886		$817,783	
Ore treated, short tons:						
Total	392,209	153,977	1,296,345	303,357	997,744	145,730
Ore from mine	371,809	152,684	1,296,245	303,357	901,529	
Purchased ores		300			275	40,469
Custom ores		993	100		26	21,886
Old tailings	20,400				95,914	83,375
Bullion contents of ores mined and treated.						
Gold—						
Ounces	73,206	44,448	221,700	41,643	343,076	49,377
Value	$1,510,026	$918,825	$4,575,854	$860,748	$7,086,087	$1,020,728
Silver—						
Ounces	27,779	70,832	65,300	3,249	1,270,021	304,364
Value	$14,319	$36,268	$31,424	$1,690	$624,759	$163,418
Other metals—						
Value		$1,670			$13,017	$5,097
Total gross value	$1,524,345	$956,763	$4,607,278	$862,438	$7,723,863	$1,189,243
Average per ton	$4	$6	$4	$3	$8	$8
Charges for treatment and freight	$9,775	$12,084	$20,512	$5,942	$402,748	$11,239
Value at works	$1,514,570	$944,679	$4,586,766	$856,496	$7,321,115	$1,178,004
Amount received for custom work		$817	$500		$52	$79,355
Total value at works	$1,514,570	$945,496	$4,587,266	$856,496	$7,321,167	$1,257,359
Average per mine or mill	$216,367	$94,550	$509,696	$285,499	$135,577	$48,360

Cyaniding plants were mostly connected with mines; very little cyaniding work was done by custom plants. The total quantity treated at the latter was only 145,730 tons, most of which was old mine and mill dumps, whereas the total quantity cyanided at plants connected with mines was 546,286 tons, not including ore treated at mines where cyaniding was combined with other processes.

The average grade of ore treated by cyaniding at the mine was worth $5 per ton; the average grade of ore treated at custom mills was higher, somewhat over $8, which is quite natural, as the ore had to bear the additional expense of transportation. The value of the ore treated at the mine where cyaniding was the only process, or combined with amalgamation, averaged $4 per ton; where it was combined with chlorination it was found possible to treat ore worth on the average about $3 per ton. In some cases the ore was sorted, ores of a higher grade or rich in silver being shipped, while low-grade ores were treated at the cyaniding plants. The following statement shows the bullion contents of ore sold in crude state:

Bullion contents of ore sold crude: 1902.

Tons sold	60,273
Bullion contents:	
Gold—	
Ounces	29,737
Value	$560,316
Silver—	
Ounces	177,707
Value	$87,787
Copper—	
Pounds	30,000
Value	$4,000
Total gross value	$652,103
Average per ton	$11
Value at mine	$412,735

Reworking old dumps and tailings.—The development of transportation facilities and the introduction of improved processes of treatment have made it profitable to rework low-grade ores which in former years were left on the dump. The quantity of such ore treated is seldom figured as a separate item in mine accounts, and was reported to the Bureau of the Census in only a few cases. Still there were 27 custom mills operating principally on old dumps and tailings. A summary of the same is presented in the table below. Of these, 16 were cyaniding, 4 amalgamating, and 7 concentrating plants. At the last named the ore was merely concentrated and then shipped to other works for treatment. The plants were not large, employing on an average about one person on a salary and about four wage-earners. The ore and tailings treated by cyaniding averaged a little over $3 per ton.

TABLE 57.—*Summary of mills operating principally on old dumps and tailings: 1902.*

	Total.	Cyaniding mills.	All others.
Number of mills	27	16	11
Salaried officials, clerks, etc.:			
Number	33	21	12
Salaries	$41,867	$33,897	$7,970
Wage-earners:			
Average number	105	65	40
Wages	$94,139	$57,932	$36,207
Miscellaneous expenses	$20,783	$14,367	$6,416
Cost of supplies and materials	$89,161	$74,058	$15,103
Cost of purchased ore and freight	$29,783		$29,783
Ore treated, short tons:			
Total	137,158	80,578	56,580
Ore from the dumps	121,854	79,475	42,379
Purchased ores	4,220	80	4,140
Custom ores	11,084	1,023	10,061
Gross value of bullion contents of ore treated:[1]			
Gold	$304,176	$218,421	$85,755
Silver	$107,961	$51,745	$56,216
Other metals	$5,672	$5,097	$575
Total	$417,809	$275,263	$142,546
Average per ton	$3	$3	$3
Treatment charges and freight	$56,764	$6,130	$50,634
Value of product at mill	$361,045	$269,133	$91,912
Amount received for custom work	$28,379	$3,206	$25,173
Total value at mill	$389,404	$272,339	$117,065
Average per mill	$14,422	$17,021	$10,642

[1] Does not include custom ores.

PLACER MINES.

The following table presents comparative statistics of the production of placer mines in 1902 and 1880:

TABLE 58.—*Gold product of placer mines, by states and territories: 1902 and 1880.*

STATE OR TERRITORY.	1902 Fine ounces.	1880 Fine ounces.
United States	535,097	580,766
Alaska	[1]276,551	288
California	182,570	415,105
Colorado	5,172	1,922
Georgia	3,290	3,254
Idaho	17,091	42,553
Montana	19,289	56,256
Nevada	1,473	2,419
New Mexico	5,722	
North Carolina	151	227
Oregon	25,794	41,811
Washington	264	5,757
All other states and territories[2]	884	5,194

[1] Estimates of Mint officers and agents.

[2] Includes Alabama, Arizona, South Carolina, South Dakota, Tennessee, Virginia, Utah, and Washington.

The decline of placer mining in continental United States is apparent from the preceding table. While making an allowance for the incompleteness of the present Census returns for placer mines, it must be remembered that those of the Tenth Census were much more defective. About one-half of the total placer product came from Alaska. Of all other states and territories, New Mexico alone has developed some placer mining since the Tenth Census.

Methods of working.—The methods of working in use in placer mines were reported as follows: Hydraulicking, 469 mines; sluicing, 349; drifting, 112; dredging, 44; electric elevator, 1. The shares contributed by these methods to the production of placer mines are shown in the following statement:

Product of placers, classified by method used: 1902.

METHOD OF WORKING.	Value of product at mine.	Per cent.
Total	$5,327,726	100.0
Hydraulicking	1,618,169	30.4
Dredging	1,329,039	24.9
Other methods	1,242,337	23.3
Not stated	1,138,181	21.4

The following table is a summary for placer mines, classified by method of working:

TABLE 59.—*Summary for placer mines, by method of working: 1902.*

	Total.	Hydraulic.	Dredging.	All others.
Number of mines	975	469	44	462
Without hired labor	396	141		255
With hired labor	579	328	44	207
Number of owners working	950	385		565
Salaries	$324,418	$142,732	$106,747	$74,939
Wages	$1,818,758	$885,101	$321,272	$612,385
Contract work	$19,953	$10,907	$2,998	$6,048
Work on share of product	$76,749	$33,502	$3,660	$39,587
Royalties	$145,727	$45,840	$69,358	$30,529
Miscellaneous expenses, exclusive of royalties	$133,758	$59,749	$57,333	$16,676
Cost of supplies and materials	$790,986	$274,745	$345,329	$170,912
Value of product at mine	[1]$4,189,545	$1,618,169	$1,329,039	[1]$1,242,337
Average per mine	$4,295	$3,450	$30,205	$2,689
Mineral lands:				
Total acreage held	186,660	108,889	18,507	59,264
Owned, acres	167,366	99,196	14,857	53,313
Leased, acres	19,294	9,693	3,650	5,951

[1] Does not include an estimated product of $1,138,181 for a number of small mines for which no reports were received directly from operators.

Hydraulicking.—The 469 mines worked by the hydraulic method were located mainly in California, where there were 221 mines. Oregon had 137 mines, Idaho 72, Colorado and Montana 10 each, and Georgia 9. All other states combined reported only 10 mines. A summary for hydraulic mines is presented in the following table:

TABLE 60.—*Summary for hydraulic mines: 1902.*

	Total.	Productive.	Developing and producing.
Number of mines	469	[1]397	72
Number of operators	469	397	72
Without hired labor	141	135	6
With hired labor	328	262	66
Number of owners working	385	364	21
Salaries	$142,732	$90,555	$52,177
Wages	$885,101	$647,866	$237,235
Contract work	$10,907	$2,770	$8,137
Work on share of product	$33,502	$33,502	
Rent and royalties:			
Water rents	$27,013	$22,794	$4,219
Land, plants, and tunnels	$17,617	$17,467	$150
Other rents and royalties	$1,210	$1,210	
Miscellaneous expenses, exclusive of rents and royalties	$59,749	$43,144	$16,605
Cost of supplies and materials	$274,745	$178,293	$96,452
Value of product at mine	$1,618,169	$1,521,562	$96,607
Average per mine	$3,450	$3,833	$1,342
Mineral lands.			
Total acreage held	108,889	80,776	28,113
Average acreage per mine	232	203	390
Owned, acres	99,196	72,348	26,848
Leased, acres	9,693	8,428	1,265

[1] Includes 1 mine for Virginia; no item shown.

About two-thirds of all mines worked by hydraulicking—viz, 307 out of 469—reported their average yield per cubic yard of gravel treated. The arithmetical mean of 260 answers for active producers was 34 cents per cubic yard, and the mean for 47 mines under development was 33 cents. The average returns are much higher than those reported at the Tenth Census, when in many mines the product was not above 10 cents per yard, and in some favorably situated workings a considerably lower rate of production was found profitable.[1] Apparently the débris legislation regulating the erection of dams for the protection of navigable waters and farming lands has added to the expense of hydraulic mining, and so permits of the working of a higher class of gravel only. This accounts for the decline of hydraulic mining, which is evidenced by the following comparative statement:

Summary for hydraulic mines: 1902 and 1870.

	1902	1870
Number of mines	469	362
Salaries	$142,732	(1)
Wages	$885,101	$906,559
Value of product at mine	$1,618,169	$2,508,531
Average per mine	$3,450	$6,930

[1] Not reported.

Placer mines combined with stamp mills.—Placer deposits are sometimes found in ancient river beds covered with a lava cap, in which case the cemented gravel is treated by crushing and amalgamation in stamp mills. Eight mines of this character were reported by the present census—7 in California and 1 in Georgia. A summary for the same follows next below:

TABLE 61.—*Summary for placer mines equipped with stamp mills: 1902.*

Number of operators	8
Salaried officials, clerks, etc.:	
Number	8
Salaries	$6,105
Wage-earners:	
Average number	67
Wages	$53,336
Contract work	$137
Work on share of product	$3,232
Miscellaneous expenses	$7,641
Cost of supplies and materials	$10,130
Value of gold at mine	$130,606
Amount received for custom work	$750
Total value of product	$131,356

Dredging.—This new method, which marks the latest technical progress in alluvial mining, deserves especial attention. The total product of gold dredged for the year 1902 was valued at $1,329,039, of which $846,421 was produced in California, $278,617 in Montana, $81,823 in Idaho, and $122,178 in Georgia and New Mexico. In 1901 the product of dredging in California was estimated at $471,762 and in 1900 at $200,000.[2]

Of the 44 mines operated by dredging, 8 were engaged mainly in developing, comparatively little gold being produced by them. These 8 mines comprised 4 in Idaho, 3 in California, and 1 in Georgia. The 36 productive mines were distributed as follows: Seventeen in California, 9 in Idaho, 5 in Montana, 3 in Georgia, and 2 in New Mexico.

There were 34 incorporated and 10 unincorporated companies. The incorporated companies were distributed by states as follows: Eighteen in California, 8 in Idaho, 5 in Montana, 2 in New Mexico, and 1 in Georgia. Of the 34 incorporated companies, 7 were reported in the development stage, and of the remaining 27 only 5 paid dividends in 1902, namely, 4 in California and 1 in New Mexico. The total dividends paid by these 5 companies amounted to $246,810, of which $4,760 was paid on $68,000 of preferred stock, averaging 7 per cent, and $242,050 on $1,104,000 of common stock issued, averaging 21.9 per cent. In addition to that, 1 company paid the sum of $7,680 as interest at the rate of 6 per cent on its outstanding bonds amounting to $128,000.

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[1] Tenth Census, Vol. XIII, Report on Precious Metals, page 200.

[2] Report of the Director of the Mint on the Production of the Precious Metals, 1901, page 91.

There was no gold dredging mine with a product of $250,000 or more. Classified by value of production reported, the 44 mines reported ranked as follows: Four with a product exceeding $100,000, and with a total of $582,598; 8 ranging between $50,000 and $100,000, with a total of $483,215; 10 ranging between $10,000 and $50,000, with a total of $199,754; 15 ranging between $1,000 and $10,000, with a total product of $59,275; 5 ranging between $500 and $1,000, and 2 producing less than $500, with a total product of $4,197. It appears from the preceding figures that four-fifths of the entire output was contributed by 12 companies, producing each between $50,000 and $250,000.

A summary for gold mines operated by dredges and the capitalization of all incorporated gold dredging companies are presented in the two tables following:

TABLE 62.—SUMMARY FOR GOLD MINES OPERATED BY DREDGES: 1902.

	Total.	Productive	Developing and producing.	Unincorporated.	INCORPORATED.			
					Total.	Dividend paying.	Nondividend paying.	
							Productive.	Developing and producing.
Number of mines	44	36	8	10	34	5	22	7
Salaries	$106,747	$90,574	$16,173	$7,512	$99,235	$20,607	$62,455	$16,173
Wages.								
Total	$321,172	$287,909	$33,263	$21,853	$299,319	$82,055	$186,551	$30,713
Engineers, firemen, etc	$138,356	$125,651	$12,705	$8,495	$129,861	$39,393	$78,813	$11,655
Miners	$26,101	$15,831	$10,270	$6,994	$19,107	$9,034	$1,303	$8,770
Boys under 16	$271	$187	$84	$187	$84	......	......	$84
All other wage-earners	$156,444	$146,240	$10,204	$6,177	$150,267	$33,628	$106,435	$10,204
Contract work	$2,998	......	$2,998	$2,998	......	......	......	......
Work on share of product	$3,600	$3,600	......	$3,600	......	......	......	......
Rent and royalties:								
Electric power	$49,510	$47,913	$1,597	......	$49,510	$19,077	$28,836	$1,597
Land, water, and other	$19,848	$19,848	......	$1,209	$18,639	$600	$18,039	......
Miscellaneous expenses, exclusive of royalties	$57,333	$49,930	$7,403	$699	$56,634	$9,617	$39,614	$7,403
Cost of supplies and materials	$345,329	$314,410	$30,919	$4,537	$340,792	$104,585	$206,288	$29,919
Value of product at mine	$1,329,039	$1,305,202	$23,837	$25,432	$1,303,607	$496,718	$784,152	$23,787
Average per mine	$30,205	$36,256	$2,980	$2,543	$38,341	$99,184	$35,643	$3,391

TABLE 63.—CAPITALIZATION OF INCORPORATED GOLD DREDGING COMPANIES, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of mines.	Total par value of stocks and bonds issued.	CAPITALIZATION.				
			Common stock.				
			Authorized.		Issued.		Dividends paid.
			Number of shares.	Par value.	Number of shares.	Par value.	
United States	34	$11,505,845	6,473,786	$11,952,800	5,405,062	$10,710,545	$242,050
Dividend paying	5	1,172,000	211,740	1,104,000	211,740	1,104,000	242,050
Nondividend paying	29	10,333,845	6,262,046	10,848,800	5,193,322	9,606,545	......
California	18	6,275,831	3,886,996	6,704,800	3,542,849	6,207,831	197,250
Georgia	1	500,000	5,000	500,000	5,000	500,000	......
Idaho	8	2,257,800	1,553,390	2,708,000	983,299	2,209,900	......
Montana	5	2,252,214	1,026,200	1,820,000	871,714	1,572,814	......
New Mexico	2	220,000	2,200	220,000	2,200	220,000	44,800

STATE OR TERRITORY.	CAPITALIZATION.										
	Preferred stock.					Bonds.					
	Authorized.		Issued.		Dividends paid.	Authorized.		Issued.		Interest paid.	
	Number of shares.	Par value.	Number of shares.	Par value.		Number.	Par value.	Number.	Par value.	Amount.	Rate per cent.
United States	208,150	$1,150,000	19,582	$633,400	$4,760	244	$184,200	219	$161,900	$7,680	6.0
Dividend paying	150	150,000	68	68,000	4,760	......	......	......	......	......	......
Nondividend paying	208,000	1,000,000	19,514	565,400	......	244	184,200	219	161,900	7,680	6.0
California	150	150,000	68	68,000	4,760	......	......	......	......	......	......
Georgia	......	......	......	......	......	......	......	......	......	......	......
Idaho	200,000	200,000	14,000	14,000	......	94	34,200	91	33,900	......	......
Montana	8,000	800,000	5,514	551,400	......	150	150,000	128	128,000	7,680	6.0
New Mexico	......	......	......	......	......	......	......	......	......	......	......

The following power was used to operate the dredges: One hundred and nineteen electric motors with 4,295 horsepower owned, in addition to which 3,762 horsepower was rented from other electrical plants, making in all 8,057 horsepower; 68 steam engines with 2,385 horsepower, and 7 water wheels with 1,740 horsepower. Most of the electric power, viz, 99 motors with 3,375 horsepower, and 3,412 horsepower rented, was used in California. The power used to run dredges constituted three-fourths of the total power used in the placer mines.

The following statement shows the area of land owned and leased by gold dredging concerns; acreage was not reported for 11 mines:

Gold dredging mineral lands owned and leased, by states and territories: 1902.

	Number of mines.	ACREAGE, MINERAL LANDS.			
		Total.	Owned.	Held on lease.	Average per mine.
United States	33	18,507	14,857	3,650	561
California	18	6,596	6,396	200	366
Idaho	9	4,603	4,603	....	511
Montana	4	4,050	3,600	450	1,012
New Mexico	2	3,258	258	3,000	1,629

The following statement shows the distribution of mineral lands among the 33 companies reporting on the subject of land tenure:

Mineral lands, classified by area held: 1902.

	Number of mines.	ACREAGE.	
		Total.	Per cent of total.
Total	33	18,507	100.0
20 acres or less	1	20	0.1
21 to 99	3	246	1.3
100 to 999	24	8,591	46.4
1,000 and over	5	9,650	52.2

It must be understood that the land ownership shown in the preceding statements represents as yet only the possibilities of gold dredging. The area actually treated during the year 1902, in so far as reported, aggregated only 214 acres, from which gold to the amount of $1,243,364 was produced. Fifteen companies, with a total product of $185,675, failed to report the total acreage treated. The average yield per acre, for mines reporting, was $5,870. Twenty-six mines, with an aggregate output of $978,508, reported their average yield per cubic yard of gravel treated. The arithmetical mean of their average returns was $0.26 per cubic yard. In computing the mean yield the cubic volume of ground treated was not considered, as it could seldom be accurately ascertained; yet the average yield reported, being the result of numerous tests made, is thought to deserve attention.

TENDENCY TOWARD CONCENTRATION.

Gold and silver mining is no exception to the general trend of modern industry toward production on a large scale. This is illustrated by the following five tables, which present a classification of all mines and mills by value of production. Table 64 comprises all mines and all mills combined with mines, showing separately placers, deep mines without mills, and deep mines with mills. Table 65 deals with custom mills only. Table 66 presents a similar classification of all mines and mills by states and territories. Table 67 presents the same classification for gold and silver and for argentiferous lead mines, and Table 68 presents the same classification for incorporated mines, dividend paying and nondividend paying mines being shown separately. Only productive mines are dealt with in the last table; mines designated as "developing and producing"—that is, those at which expenditures were in excess of receipts—are eliminated from the comparison. In order to avoid disclosing the identity of individual concerns it has been necessary in Tables 65, 66, and 68 to combine certain groups shown separately in Tables 64 and 67.

TABLE 64.—CLASSIFICATION OF MINES BY VALUE OF PRODUCT: 1902.

	TOTAL.[1]			PLACERS.			DEEP MINES WITHOUT MILLS.			DEEP MINES WITH MILLS.		
	Number of operators.	Value of product.	Per cent.	Number of operators.	Value of product.	Per cent.	Number of operators.	Value of product.	Per cent.	Number of operators.	Value of product.	Per cent.
United States	2,937	$80,144,545	100.0	975	$5,327,726	100.0	1,275	$25,537,401	100.0	687	$49,279,418	100.0
Less than $500	765	161,531	0.2	353	77,974	1.5	332	64,690	0.2	80	18,867	0.1
$500 to $999	415	295,816	0.4	181	126,636	2.4	171	123,104	0.5	63	46,076	0.1
$1,000 to $9,999	1,134	3,976,980	5.0	359	1,118,667	21.0	505	1,827,904	7.2	270	1,030,409	2.1
$10,000 to $49,999	372	8,697,817	10.8	66	1,324,001	24.8	181	4,202,063	16.5	125	3,171,753	6.4
$50,000 to $99,999	102	7,163,460	8.9	10	643,695	12.1	33	2,325,969	9.1	59	4,193,796	8.5
$100,000 to $249,999	73	10,682,727	13.3	6	898,572	16.9	30	4,363,214	17.1	37	5,420,941	11.0
$250,000 to $499,999	45	15,517,681	19.4	....	....	....	16	5,717,847	22.4	29	9,799,834	19.9
$500,000 to $999,999	20	13,749,151	17.2	....	....	....	4	2,701,476	10.6	16	11,047,675	22.4
$1,000,000 and over	11	18,265,547	22.8	....	....	....	3	3,715,480	14.5	8	14,550,067	29.5
Not classified	....	1,633,835	2.0	....	1,138,181	21.8	....	495,654	1.9	....	....	....

[1] Exclusive of custom mills.

TABLE 65.—CUSTOM MILLS, CLASSIFIED BY VALUE OF PRODUCT: 1902.

	Number of mills.	Value of product.	Per cent of total.
Total	55	$8,700,059	100.0
Less than $500	10	2,059	(1)
$500 to $999	6	3,520	(1)
$1,000 to $9,999	24	87,113	1.0
$10,000 to $49,999	7	187,182	2.2
$50,000 to $249,999	4	428,771	4.9
$250,000 and over[2]	4	7,986,274	91.8

[1] Less than one-tenth of 1 per cent.

[2] Includes 3 establishments each with product over $1,000,000.

TABLE 66.—CLASSIFICATION OF MINES AND MILLS ACCORDING TO VALUE OF PRODUCT, AND THE PERCENTAGE THAT EACH GROUP IS OF THE TOTAL, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	TOTAL.		LESS THAN $1,000.		$1,000 TO $9,999.		$10,000 TO $49,999.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
United States	2,992	$82,482,052	1,196	$463,266	1,158	$4,062,016	382	$8,929,566
Arizona	74	2,764,677	23	9,233	29	132,991	13	296,347
California	1,020	15,469,609	439	164,266	400	1,296,270	119	2,631,888
Colorado	772	29,659,456	279	102,869	286	1,070,944	116	2,676,979
Idaho	258	8,177,257	122	51,674	97	310,525	20	453,294
Montana	176	4,688,536	46	16,688	70	288,958	39	965,925
Nevada	104	3,409,348	29	13,809	40	153,104	21	580,528
South Dakota	40	6,464,258	8	3,383	15	63,696	4	145,451
Utah	83	8,500,904	23	10,817	27	129,763	14	379,648
All other states and territories[1]	465	3,347,997	227	87,528	194	635,822	33	799,306

STATE OR TERRITORY.	$50,000 TO $99,999.		$100,000 AND OVER.		NOT CLASSIFIED.	PER CENT OF TOTAL.					
	Number.	Value.	Number.	Value.	Value.	Less than $1,000.	$1,000 to $9,999.	$10,000 to $49,999.	$50,000 to $99,999.	$100,000 and over.	Not classified.
United States	103	$7,221,740	153	$60,171,929	$1,633,535	0.6	4.9	10.8	8.8	72.9	2.0
Arizona	3	198,625	6	2,121,201	11,277	0.4	4.8	10.7	7.0	76.7	0.4
California	30	2,087,562	32	8,159,465	1,130,158	1.1	8.4	17.0	13.5	52.7	7.3
Colorado	27	1,994,643	64	23,824,768	9,253	0.3	3.6	9.0	6.7	80.3	(2)
Idaho	7	531,531	12	6,772,023	55,221	0.7	3.8	5.5	6.5	82.8	0.7
Montana	12	744,668	9	2,672,267	....	0.3	6.2	20.6	15.9	57.0	......
Nevada	6	449,903	8	2,069,564	145,140	0.4	4.5	17.0	13.2	60.6	4.3
South Dakota	5	365,135	8	5,886,683	....	0.1	1.0	2.2	5.6	91.1	......
Utah	6	404,591	13	7,576,085	....	0.1	1.5	4.5	4.8	89.1	......
All other states and territories[1]	7	450,082	4	1,092,773	282,486	2.6	19.0	23.9	13.5	32.6	8.4

[1] Includes Alabama, Arkansas, Georgia, Maryland, New Mexico, North Carolina, Oregon, South Carolina, Tennessee, Texas, Virginia, Washington, and Wyoming.

[2] Less than one-tenth of 1 per cent.

TABLE 67.—CLASSIFICATION OF DEEP MINES BY METALS MINED AND BY VALUE OF PRODUCT: 1902.

	TOTAL.			GOLD AND SILVER.			ARGENTIFEROUS LEAD.		
	Number of companies.	Value of product.	Per cent.	Number of companies.	Value of product.	Per cent.	Number of companies.	Value of product.	Per cent.
Total[1]	1,935	$73,961,544	100.0	1,488	$50,587,106	100.0	447	$23,374,438	100.0
Less than $500	409	82,687	0.1	322	63,746	0.1	87	18,941	0.1
$500 to $999	233	168,468	0.2	178	130,202	0.3	55	38,266	0.2
$1,000 to $9,999	759	2,773,347	3.8	602	2,181,509	4.3	157	591,838	2.5
$10,000 to $49,999	301	7,265,451	9.8	220	5,277,243	10.4	81	1,988,208	8.5
$50,000 to $99,999	90	6,356,057	8.6	66	4,584,228	9.1	24	1,771,829	7.6
$100,000 to $249,999	67	9,784,155	13.2	50	7,296,492	14.4	17	2,487,663	10.6
$250,000 to $499,999	45	15,517,681	21.0	29	9,878,109	19.5	16	5,639,572	24.1
$500,000 to $999,999	20	13,749,151	18.6	15	9,951,218	19.7	5	3,797,933	16.3
$1,000,000 and over	11	18,265,547	24.7	6	11,225,359	22.2	5	7,040,188	30.1

[1] Exclusive of custom mills and mills operated upon old dumps and tailings.

DIAGRAM I.—PRODUCTION OF GOLD FROM 1889 TO 1902 IN THE STATES AND TERRITORIES REPORTING MORE THAN 50,000 OUNCES IN 1902.

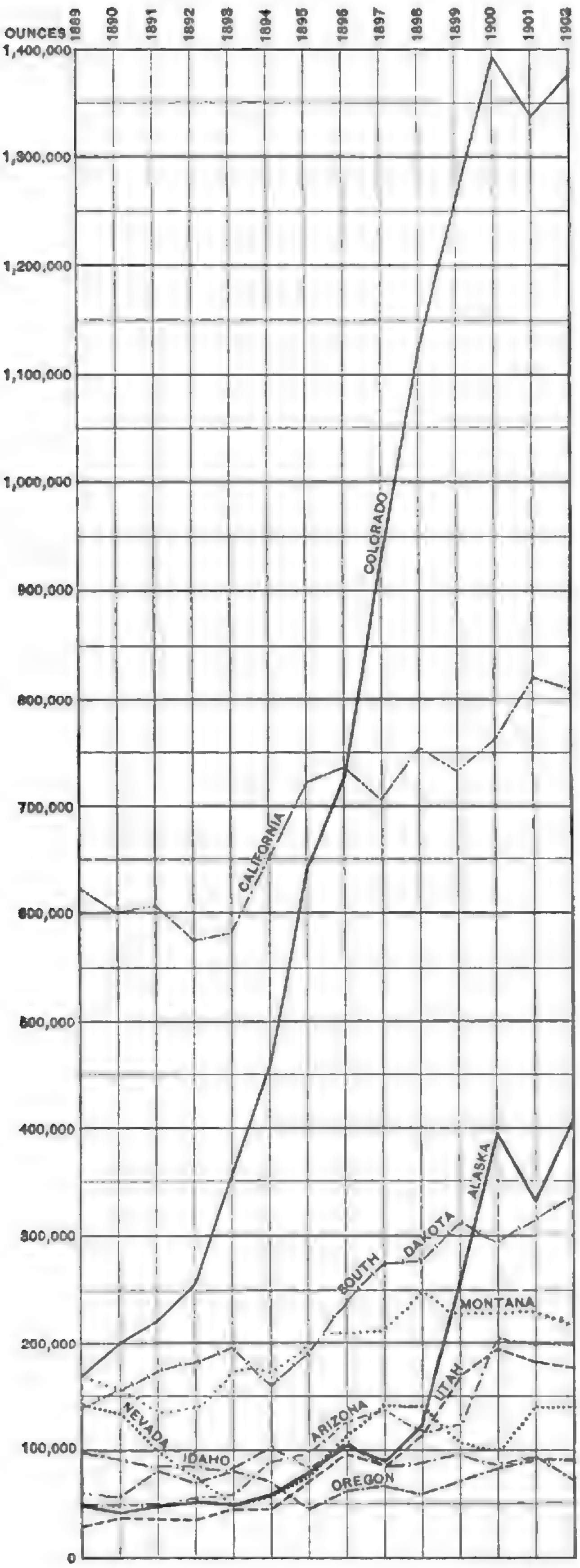


TABLE 68.—*Dividend paying and nondividend paying productive mines, deep and placer, classified by value of product: 1902.*

	DIVIDEND PAYING.			NONDIVIDEND PAYING.		
	Number of companies.	Product.	Per cent.	Number of companies.	Product.	Per cent.
All mines	121	$34,248,315	100.0	614	$31,343,626	100.0
Less than $1,000				103	45,233	0.1
$1,000 to $9,999	13	73,071	0.2	230	965,544	3.1
$10,000 to $49,999	25	686,332	2.0	152	4,019,708	12.8
$50,000 to $99,999	21	1,452,785	4.3	56	4,087,670	13.0
$100,000 to $249,999	16	2,718,437	7.9	49	7,497,403	23.9
$250,000 to $499,999	25	8,839,714	25.8	14	4,848,736	15.5
$500,000 and over	21	20,477,976	59.8	8	9,899,134	31.6
Deep mines and mills	102	33,251,898	100.0	535	29,985,701	100.0
Less than $1,000				86	35,370	0.1
$1,000 to $9,999	6	31,087	0.1	198	818,893	2.7
$10,000 to $49,999	21	610,072	1.8	130	3,482,359	11.6
$50,000 to $99,999	17	1,212,275	3.6	52	3,664,685	12.2
$100,000 to $249,999	12	2,080,774	6.3	47	7,236,494	24.2
$250,000 to $499,999	25	8,839,714	26.6	14	4,848,736	16.2
$500,000 and over	21	20,477,976	61.6	8	9,899,134	33.0
Placer mines	19	996,417	100.0	79	1,357,925	100.0
Less than $1,000				17	9,863	0.7
$1,000 to $9,999	7	41,984	4.2	32	146,651	10.8
$10,000 to $49,999	4	76,260	7.7	22	537,317	39.6
$50,000 to $249,999	8	878,173	88.1	8	664,094	48.9

PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES FROM 1889 TO 1902.

The statistics of the production of the mines are collected annually by Mint officers and agents from mine operators. The statistics of the production of refineries are collected by the Bureau of the Mint. The former, as a rule, show an excess over the latter, varying from 1 per cent to 11.4 per cent for gold and from one-tenth of 1 per cent to 11.3 per cent for silver. In 1890, however, the estimate of the Director of the Mint exceeded the total gold product reported by Mint agents by 2.9 per cent. The estimated production of silver refineries exceeded the product of the mines in 1891 by five-tenths of 1 per cent, in 1893 by 13.2 per cent, and in 1896 by 8.5 per cent. The estimated production of refined silver is equal to the total silver production of domestic refineries less the silver contents of foreign ores reduced in the United States. The fluctuations in imports of silver must inevitably affect the estimate of the refined product, thus creating a disproportion between the latter and the production of the mines in the United States for the same year.

The excess appearing from year to year in the production reported by mine operators, as compared with the product of refineries, is easily accounted for by the fact that the former is largely an estimate of the assay contents of all ore mined, regardless of the quantity of ore which will eventually be left on the dump after sorting, as being of too low a grade to pay for freight and reduction; nor are the losses in smelting always considered by the mine operator in estimating the assay contents of his ore.

The following table shows the gold and silver product of mines and refineries from 1889 to 1902, compiled from the annual reports of the Director of the Mint on the production of the precious metals:

TABLE 69.—PRODUCT OF MINES AND REFINERIES: 1889 TO 1902.

YEAR.	GOLD.				SILVER.			
	Product of mines.	Product of refineries.	Excess of mined product over refined product.		Product of mines.	Product of refineries.	Excess of mined product over refined product.	
	Fine ounces.	Fine ounces.	Fine ounces.	Per cent of mined product.	Fine ounces.	Fine ounces.	Fine ounces.	Per cent of mined product.
1902	3,913,681	3,870,000	43,681	1.1	57,836,558	55,500,000	2,336,558	4.0
1901	3,853,222	3,805,500	47,722	1.2	57,873,486	55,214,000	2,659,486	4.6
1900	3,867,644	3,829,897	37,747	1.0	60,211,386	57,647,000	2,564,386	4.3
1899	3,513,244	3,437,210	76,034	2.2	56,721,178	54,764,500	1,956,678	3.4
1898	3,184,734	3,118,398	66,336	2.1	55,486,833	54,438,000	1,048,833	1.9
1897	2,916,245	2,774,935	141,310	4.8	56,115,165	53,860,000	2,255,165	4.0
1896	2,775,141	2,568,132	207,009	7.5	54,219,669	58,834,800	[1] 4,615,131	[1] 8.5
1895	2,544,352	2,254,760	289,592	11.4	57,238,932	55,727,000	1,511,932	2.6
1894	2,110,599	1,910,813	199,786	9.5	51,028,617	49,500,000	1,528,617	3.0
1893	1,788,482	1,739,323	49,159	2.7	53,017,449	60,000,000	[1] 6,982,551	[1] 13.2
1892	1,665,626	1,597,098	68,528	4.1	58,050,975	58,004,289	46,686	0.1
1891	1,661,325	1,604,840	56,485	3.4	58,067,932	58,330,000	[1] 262,068	[1] 0.5
1890	[2] 1,544,033	1,588,877	[1] 44,844	[1] 2.9	[3] 56,320,640	54,516,300	1,804,340	3.2
1889	1,599,166	1,504,775	94,391	5.9	56,452,025	50,094,571	6,357,454	11.3

[1] Excess of refined over mined product.

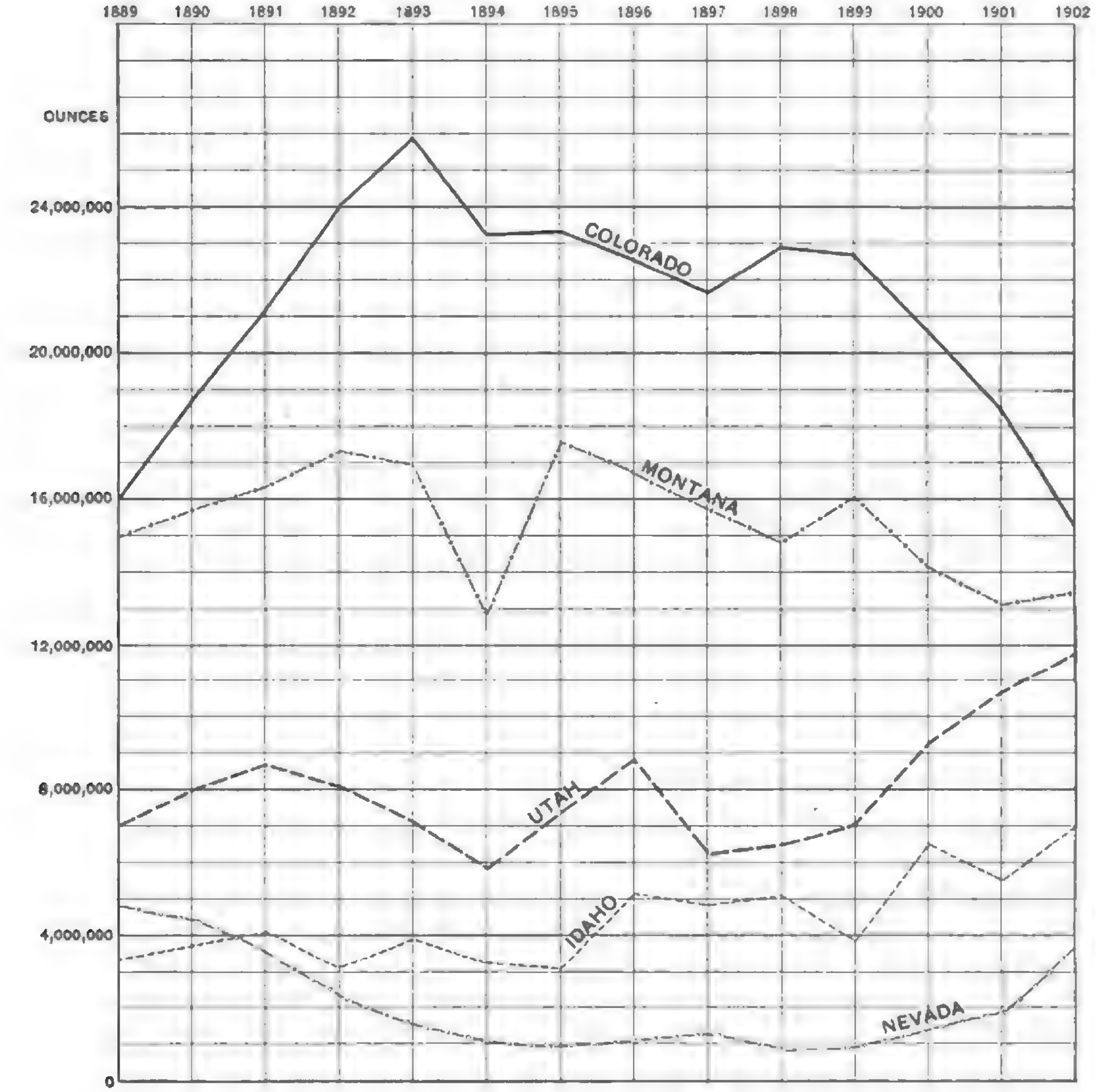
[2] Exclusive of 1,955 ounces reported for "other states" in the Report of the Director of the Mint, which was evidently a duplication.

[3] Exclusive of 2,000 ounces reported for "other states" in the Report of the Director of the Mint, which was evidently a duplication.

REVIEW OF THE INDUSTRY BY STATES.

The development of the production of gold and silver in the several states and territories from 1889 to 1902 is illustrated by Diagrams I, II, III, and IV. Diagram I, based upon the estimates of the Director of the Mint, shows the growth of the gold production in the principal states and territories and the rank of each as a gold producer; the wide variance between the Mint estimates of the gold output by states and territories and the corresponding Census returns precludes the use of the latter for comparative purposes. The fluctuations of the silver production in the principal states during the same period are represented by Diagram II, prepared from the same source, except for the year 1902, for which Table 40 of the present report was used. Dia-

DIAGRAM II.—PRODUCTION OF SILVER FROM 1889 TO 1902 IN THE STATES REPORTING MORE THAN 2,500,000 OUNCES IN 1902.



grams III and IV, prepared from the same source as Diagram II, show the share contributed by each state and territory to the total production of gold and silver from year to year.

Colorado held in 1902 the first rank among the states and territories as a producer of both gold and silver. The Colorado ores contributed more than one-third of the gold and more than one-fourth of the silver contents of all ores mined in the United States. The second place among the gold producing states was held by California, which contributed over one-fifth of the gold product of the United States. Next after California came Alaska, with one-ninth of the total gold product and with more than one-half of the placer gold produced in the United States. South Dakota, Montana, Utah, Arizona, Oregon, Nevada, and Idaho followed in successive order. All other states and territories each produced less than $1,000,000 in gold.

The second rank as a silver producing state was held by Montana, which furnished nearly one-fourth of the silver contents of all ores. Nearly three-fourths of the silver was derived as a by-product of the smelting of copper ores, viz, 9,675,613 fine ounces out of a total of 13,441,950 ounces. Utah followed closely, with over one-fifth of the total output of silver. Idaho and Nevada came next. All other states and territories each produced less than $1,000,000 in silver.

Silver, as previously stated, was mostly recovered from argentiferous lead ores, where lead formed a valuable portion of the product. The first rank as a producer of argentiferous lead ores was held by Idaho. The combined silver and lead contents of all ores mined in that state were valued at $10,291,494. Utah followed next, with a total value of $8,261,095, and Colorado held the third rank, with $7,296,925. The production of argentiferous lead ores in other states was insignificant. The Colorado ores were the richest in silver, only one-fourth of the value of their bullion contents representing lead. The value of the bullion contents of Utah argentiferous lead ores was nearly two-thirds in silver and a little over one-third in lead. In Idaho, on the contrary, the ores were poor in silver, more than two-thirds of the value of their metallic contents being lead and less than one-third silver.

Taking the lead values alone, Idaho contributed $7,122,838; Utah, $2,873,740; Colorado, $1,827,993; and all other states $486,671. These values do not correspond to the quantities of lead, inasmuch as the price realized in Idaho averaged 3.4 cents per pound of fine lead contents, whereas in Utah it averaged 2.7 cents and in Colorado 2.25 cents per pound. The lead contents of Idaho ores were more than one-half of the total for all argentiferous lead ores mined in the United States. Utah contributed a little over one-fourth and Colorado about one-fifth.

A shifting of the relative positions held by the several states and territories as gold producers has taken place since the Eleventh Census. In 1889 California held the first rank; its product, as estimated by the Director of the Mint, was nearly four times as large as that of Colorado. While its production shows a small increase from year to year, yet it did not keep pace with the rapidly increasing production of Colorado, which in 1897 took the first rank and has retained it since. Alaska, which in 1889 was among the minor producers, in 1902 reached the third place, next to California.

No change has taken place in the relative positions of the three principal silver producing states, viz, Colorado, Montana, and Utah. But while the silver production of Colorado and Montana, after a period of increase up to 1895, shows a considerable decline, the silver production of Utah has substantially increased since 1889. Nevada and Idaho, which in 1889 occupied respectively the fourth and the fifth rank, have changed places, Idaho having kept up a steady increase. From 1889 to 1899 the silver production of Nevada sank into insignificance. Since 1900, however, there has been an increase, and in 1902 the silver production of Nevada was almost as great as in 1889. The variance previously referred to between the Census returns and Mint estimates for Arizona, Nevada, and Idaho accounts for the apparent decrease in 1902 of the gold production of Arizona and Nevada and for the increase of the silver production of Idaho.

It is interesting to note the relative places of the two precious metals in the principal gold and silver producing states in 1902. In Colorado a very notable change has taken place since the Eleventh Census. In 1889 the value of gold amounted to $3,883,859, and the coining value of silver to $23,757,751, which was equivalent—at the commercial rate of 93.5 cents per fine ounce[1]—to $17,500,000 in round numbers. In 1902 the value of the gold contents of Colorado ores was $26,414,800, while the commercial value of their silver contents was $7,740,227, which corresponded to a coining value of $19,617,392. Thus while the decrease of the commercial value of the silver product was nearly $10,000,000, the loss was made up by the increase in the value of the gold product, and there was a surplus of about $13,000,000 in the aggregate commercial value of both metals. The increase in the value of the gold and silver contents of the Colorado ores since 1889 amounted to 60 per cent.

In California and South Dakota the production of silver was insignificant, while in Montana and Utah the silver contents of the ores largely exceeded in value their gold contents.

Alaska.—The census of mines and quarries in 1902 did not extend to Alaska. Still, correspondence with the mining companies operating in the territory has brought replies covering all essential inquiries relating to deep mining for precious metals in the territory. There were in operation during the year 1902, 7 deep gold and silver mines, all equipped with mills for the treatment of ores. A summary of these mines is presented in the following table:

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1902, page 312.

TABLE 70.—*Summary of deep mines in Alaska: 1902.*

	Total.	Mines.	Mills.
Number of mines and mills	7	7	7
Number of operators	6	6	6
Number of incorporated companies	6	6	......
Capital stock			
Authorized, common—			
Number of shares	1,000,000	1,000,000	....
Par value	$27,200,000	$27,200,000	....
Issued, common—			
Number of shares	878,710	878,710	....
Par value	$25,919,510	$25,919,510	....
Dividends paid	$375,000	$375,000	....
Salaries	$80,459	$73,321	$7,138
General officers	$10,687	$10,687	....
Superintendents, etc	$58,016	$50,878	$7,138
Clerks	$10,130	$10,130	....
Foremen	$1,626	$1,626	....
Wages	$821,541	$718,736	$102,805
Engineers	$113,746	$99,709	$14,037
Miners	$336,034	$336,034	....
All other wage earners	$371,761	$282,993	$88,768
Miscellaneous expenses	$48,169	$43,548	$4,621
Contract work	$5,656	$5,656	....
Cost of supplies and materials	$700,669	$543,220	$157,449
Construction account	$105,599	$105,599	....
Total value of product at mine	[1] $2,486,183	....	$2,419,444
Tons mined	1,333,288	1,333,288	....
Tons milled	1,329,988	....	1,329,988
Tons of concentrates shipped	25,856	....	25,856
Aggregate gross value	$2,615,783	....	$2,615,783
Average per ton of ore treated	$1.97	....	$1.97
Gross value of ore milled	$1,366,734	....	$1,366,734
Refining charges	$3,272	....	$3,272
Freight and insurance	$9,555	....	$9,555
Value at mine	$1,353,907	....	$1,353,907
Gross value of concentrates shipped	$1,249,049	....	$1,249,049
Charges for treatment	$126,525	....	$126,525
Freight	$44,427	....	$44,427
Haulage	$12,560	....	$12,560
Value at mine	$1,065,537	....	$1,065,537
Income from other sources	[2] $66,739	....	....
Total contents of ore treated			
Gold—			
Ounces	126,327	....	126,327
Value	$2,609,143	....	$2,609,143
Silver—			
Ounces	7,828	....	7,828
Value	$3,638	....	$3,638
Lead—			
Pounds	96,580	....	96,580
Value	$3,002	....	$3,002
Bullion produced:			
Gold—			
Ounces	66,154	....	66,154
Value	$1,366,306	....	$1,366,306
Silver—			
Ounces	926	....	926
Value	$428	....	$428
Concentrates, bullion contents:			
Gold—			
Ounces	60,173	....	60,173
Value	$1,242,837	....	$1,242,837
Silver—			
Ounces	6,902	....	6,902
Value	$3,210	....	$3,210
Lead—			
Pounds	96,580	....	96,580
Value	$3,002	....	$3,002

[1] Includes $66,739 income from other sources.
[2] Income that can not be credited to mines or mills.

The bullion contents of gold and silver ore produced in 1902, as shown in the preceding table, were as follows: Gold, 126,327 fine ounces, valued at $2,609,143; silver, 7,828 ounces, valued at $3,638.

In addition to these quantities three copper mining companies reported to the Bureau of the Census the assay contents of their copper ore as follows: Gold, 370 fine ounces, worth $7,016; silver, 3,140 fine ounces, worth $1,567.

This makes in all 126,697 fine ounces of gold, valued at $2,616,159, and 10,968 ounces of silver, valued at $5,205. The Mint agents estimated the product of Alaska deep mines as follows: Gold, 124,156 fine ounces; silver, 89,388 fine ounces.

The Census returns from producers exceed the Mint agents' estimate of the gold product by 2,541 ounces. The Mint agents' estimate of the silver product of deep mines is many times in excess of the Census returns from producers. Inasmuch as no allowance is made in the silver estimate for the silver contents of placer bullion, which on a gold product of about $2,500,000 must be considerable, it is apparent that the estimate is meant to comprise the silver contents both of ore and of placer bullion. The product of placer mines is estimated by the Mint agents at 276,554 fine ounces.

The total product of Alaska in 1902, as estimated by the Director of the Mint, is somewhat above that of the Mint agents, viz: Gold, 403,730 fine ounces, worth $8,345,800; silver, 92,000 fine ounces, worth $118,950. This estimate is accepted by the Bureau of the Census.

The growth of the gold production of Alaska since 1890 is shown in the following table, compiled from the annual reports of the Director of the Mint on the production of the precious metals. The statistics for some years include silver; the percentage of silver in Alaska ores is, however, so insignificant that the error may be disregarded.

TABLE 71.—*Production of gold in Alaska: 1890 to 1902.*

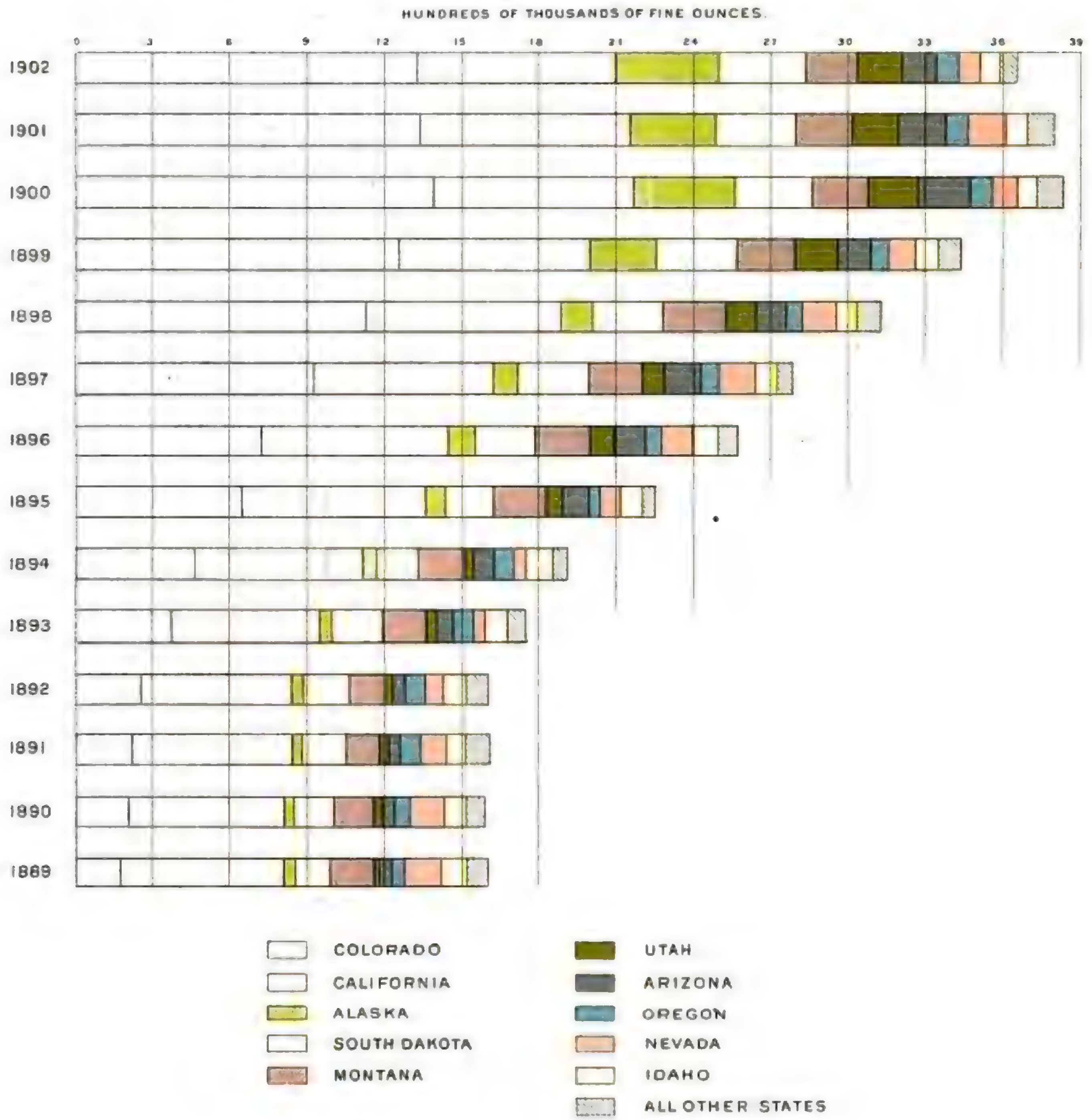
[Compiled from Report of Director of the Mint.]

Year.	Total value.	Quartz.	Placer.
Total	$44,610,473	$18,747,306	$25,863,167
1890	762,429	687,429	75,000
1891	1,020,045	880,045	140,000
1892	1,060,446	845,046	215,400
1893	1,038,824	779,782	259,042
1894	1,282,623	759,350	523,273
1895	2,328,419	1,311,337	1,017,082
1896	2,861,307	1,370,862	1,490,445
1897	2,439,582	1,760,793	678,789
1898	2,517,121	1,010,356	1,506,765
1899	5,831,355	2,704,176	3,127,179
1900	8,166,187	2,089,818	6,076,369
1901	6,998,726	1,981,775	5,016,951
1902	8,283,409	2,566,537	5,716,872

The preceding table shows that the growth of Alaska as a gold mining district is chiefly due to the development of placer mining, which has, since 1898, outrun the production of deep mines, whereas previous to 1898 the placer production amounted to 34.5 per cent of the total output. The share of placer mines in the total production for 1898 to 1902 amounted to 67.4 per cent.

The history of deep mining in Alaska is practically a record of the work of three companies, the Alaska Treadwell, the Alaska-Mexican, and the Alaska United gold mining companies, which are controlled by the same interests and operated under a joint management. The annual statements of these companies to their stockholders set forth in minutest detail the accounts of their operations and furnish an instructive example of the successful mining of low-grade ores. By courtesy of

DIAGRAM III.—PRODUCTION OF GOLD: 1889 TO 1902.



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President William Alvord, the Bureau of the Census has been given the privilege of using these statements in the present report.

The Alaska Treadwell Gold Mining Company is the oldest of the three companies. It is incorporated with a capital stock of $5,000,000, divided into 200,000 shares of $25 each, all issued. The mine has been in active operation since August, 1885, and yielded during that time $13,484,311 in gold, at an average of $2.57 per ton; the operating costs for the same period averaged $1.29 per ton. The operating profits aggregated $6,742,149.58, and have thus more than repaid the entire capital stock at its par value. The yield per ton has been declining, but the operating costs have also been materially reduced, while the tonnage crushed has more than trebled since 1890. As a result, the company's operating profits for the year 1902 were considerably larger than in years past when the yield per ton was higher. The progress in the methods of treating the ore is evidenced by the fact that while the yield in free gold has been steadily decreasing, the value saved by reworking the ore after the free gold is extracted shows a marked increase both in amount and in proportion to the total recovery. The results accomplished by the company are shown in the following statement:

Bullion shipments from Paris or Treadwell mine: 1890 to 1902.

[From beginning of work to May, 1903.]

DATE.	Tons crushed.	YIELD.			Operating profits.	Yield per ton.	Operating costs per ton.
		Total	Free gold.	Concentrates (sulphurets).			
Total	4,624,289	$11,144,912.24	$7,069,917.85	$4,074,994.39	$5,667,149.58	$2.41	$1.18
1890-91, June to May	220,696	769,765.80	531,185.77	238,580.03	418,289.90	3.49	1.59
1891-92, June to May	239,633	707,017.37	508,894.81	198,122.56	361,980.16	2.95	1.44
1892-93, June to May	237,245	694,658.74	504,785.46	189,873.28	385,613.79	2.94	1.30
1893-94, June to May	220,043	705,948.03	518,194.34	187,753.69	429,948.86	3.20	1.25
1894-95, June to May	241,278	626,327.06	411,070.66	215,256.40	309,734.56	2.60	1.31
1895-96, June to May	263,670	782,829.67	528,958.80	253,870.87	497,342.22	2.97	1.08
1896-97, June to May	242,027	676,064.88	452,407.30	223,657.58	376,450.90	2.79	1.24
1897-98, June to May	254,329	586,857.42	389,740.00	197,117.42	313,075.60	2.31	1.20
1898-99, June to May	250,408	677,655.13	441,282.25	236,372.88	386,792.34	2.71	1.28
1899-1900, June to May	557,960	1,153,367.00	773,165.69	380,201.31	669,301.20	2.07	0.86
1900-1901, June to May	457,802	860,730.58	559,120.37	301,610.21	377,417.34	1.88	1.05
1901-2, June to May	682,893	1,304,720.54	665,591.27	639,129.27	481,683.94	1.91	1.20
1902-3, June to May	756,325	1,598,963.42	785,515.13	813,448.29	659,849.77	2.11	1.24

The total assay value of the ore treated at the company's two mills during the fiscal year ending on May 15, 1903, was $1,697,507, and the total net value recovered in the mills was $1,613,991—i. e., about 95 per cent of the assay contents. The total yield per ton for the same year was $2.11, of which $1.04 was free gold and $1.07 was saved in sulphurets. The average value of sulphurets per ton after concentration was $52.58. The net profit for the year was $692,208.94, out of which $375,000 were paid in dividends during the year. The amount written off for depreciation was $448,493. During the year there was an average of 33 machine drills at work in the mine. The average number of drills used in mining the ore (stoping) was 14.5. The others were used in development and other kinds of work. The average work of one machine per shift of ten hours was 38 tons.

The Alaska-Mexican Gold Mining Company is incorporated with a capital stock of $1,000,000, divided into 200,000 shares of $5 each, of which $900,000 are outstanding. The mine has been in active operation since 1894, and has yielded during that time $2,816,279 in gold, at an average of $2.18 per ton. The operating cost averaged for the same period $1.73 per ton. The operating profits aggregated $587,912, out of which $465,381 were paid in dividends. What has been said above of the Alaska Treadwell Mining Company in regard to the grade of ore and the values recovered in sulphurets is likewise true of the Alaska-Mexican mine, as shown by the following statement:

Bullion shipments from Alaska-Mexican mine: 1894 to 1902.

[From beginning of operations to December 15, 1902.]

YEAR.	Tons crushed.	YIELD.			Operating profits.[1]	Total yield per ton.	Operating costs per ton.	Operating profits per ton.
		Total	Free gold (including base bars).	Concentrates (sulphurets).				
Total	1,293,662	$2,816,278.83	$1,859,261.20	$957,017.63	$587,911.92	$2.18	$1.73	$0.45
1894	73,141	204,042.46	154,643.33	49,399.13	60,215.60	2.79	1.97	0.82
1895	79,389	226,258.07	155,637.54	70,620.53	71,391.78	2.85	1.95	0.90
1896	101,702	245,861.98	169,532.32	76,329.66	61,650.43	2.42	1.81	0.61
1897	158,005	335,628.67	226,321.71	109,306.96	87,101.46	2.12	1.57	0.55
1898	162,457	375,882.36	257,481.67	118,397.69	100,663.07	2.31	1.69	0.62
1899	166,054	347,414.95	231,841.23	115,573.71	62,333.42	2.09	1.73	0.38
1900	166,449	315,065.45	233,165.08	81,900.37	33,521.02	1.89	1.69	0.20
1901	178,960	339,452.31	213,923.07	125,529.24	24,709.61	1.90	1.76	0.14
1902	207,155	426,732.56	216,772.25	209,960.31	86,025.51	2.06	1.64	0.41

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[1] Included in the operating profits is a total of $3,573.79, distributed as follows: Profit on sale of 31,000 shares of stock in 1893, $575.96; interest received in 1898, $694.46; interest received in 1899, $1,682.76; interest received in 1900, $620.62.

The grade of ore mined in 1902 was the same as that of the Alaska Treadwell Gold Mining Company. The average value per ton was $2.06, of which $1.04 was recovered in free gold and $1.02 was saved in sulphurets. The average value of sulphurets per ton, after concentration, in 1902 was $59.51. The net profit for the year was $86,025.

The following summary is compiled from the profit and loss accounts of the Alaska Treadwell Gold Mining Company for the year ending May 31, 1903, and the Alaska Mexican and the Alaska United gold mining companies for the calendar year 1902:

Profit and loss account of the Alaska Treadwell, Alaska-Mexican, and Alaska United gold mining companies.

	Alaska Treadwell (year ending May 31, 1903).	Alaska-Mexican (calendar year 1902).	ALASKA UNITED.	
			Ready Bullion Mine (calendar year 1902).	Seven Hundred Foot Mine (calendar year 1902).
Ore mined, tons	736,325	207,455	226,522	118,541
Ore milled, tons	736,325	207,455	226,522	118,541
Sulphuret saved, tons	15,470.79	3,628.28	4,158.80	1,271.39
EXPENSES PER TON.				
Mining	[1]$0.9022	[1]$1.0630	[2]$0.9964	$0.7698
Milling	0.1614	[3]0.2282	[4]0.3176	[4]0.1912
Sulphuret	0.1487	0.1248	0.1323	0.0694
General expense at Douglas Island	0.0068	0.0193	0.0136	0.0219
San Francisco office	0.0095	0.0112	0.0060	0.0096
London office	0.0017	0.0030	0.0012	0.0019
Paris office	0.0003	0.0005		
Consulting engineers	0.0016	0.0049	0.0021	0.0059
Bullion charges	0.0096	0.0100	0.0081	0.0075
Litigation				0.0840
Total operating expense	1.2417	1.4649	1.4768	1.1612
Construction cost	0.0454	[5]0.1774	0.0220	0.0065
Total operating and construction cost	1.2871	1.6423	1.4988	1.1677
RECEIPTS PER TON.				
Free gold	1.0362	1.0199	0.8584	0.8113
Base bars	0.0024	0.0250	0.0118	
Sulphurets	1.0755	1.0121	0.6049	0.5197
Total	2.1141	2.0570	1.4751	1.3310
Interest	0.0019			
Profits from other sources	0.0863			
Grand total	2.2023	2.0570	1.4751	1.3310
Net profit for year	0.9152	0.4147		0.1633
Deficit for year			0.0237	

[1] Includes cost of development work.
[2] Includes cost of concentrating 3,722.27 tons sulphurets.
[3] Includes cost of concentrating 4,640 tons sulphurets.
[4] Includes cost of concentrating 2,188 tons sulphurets.
[5] $0.1150 per ton of reconstruction work.

The Alaska United Gold Mining Company is the youngest of the three companies. It began operations on the Ready Bullion claim in November, 1898, and on the Seven Hundred Foot claim in April of the following year. The total yield of the former from beginning of operations to December 15, 1902, aggregated $1,539,480, averaging $2.03 per ton. The operating cost averaged $1.72 per ton and the operating profits 31 cents per ton.

The Seven Hundred Foot claim produced from the beginning of operations to December 15, 1902, $665,376 in gold and base ores, averaging $1.59 per ton; the operating cost averaged $1.56 per ton, leaving a profit of 3 cents per ton. The company was capitalized at $1,000,000, divided into 200,000 shares of $5 each, of which $901,000 are outstanding. The total operating profits since organization amounted to $250,491. There was a deficit for the year on the Ready Bullion claim amounting to 2 cents per ton, but the construction account on the same mine, charged to current expenses, likewise averaged 2 cents per ton.

California.—California had more operators than any other state, viz, more than one-third of the total number reported for the United States. Eliminating from the latter total the 447 argentiferous lead mines and considering only gold and silver mines, California had about two-fifths of the total number of operators reported for the United States. This does not include small operators from whom no individual reports were received; the latter were also located chiefly in California. Of the total estimated value of the product of small mines, 70 per cent, viz, $1,130,158, was reported from California. It is therefore a fair estimate that there were in 1902 more operators of gold mines in California than in all other states and territories, Alaska not being included in the comparison.

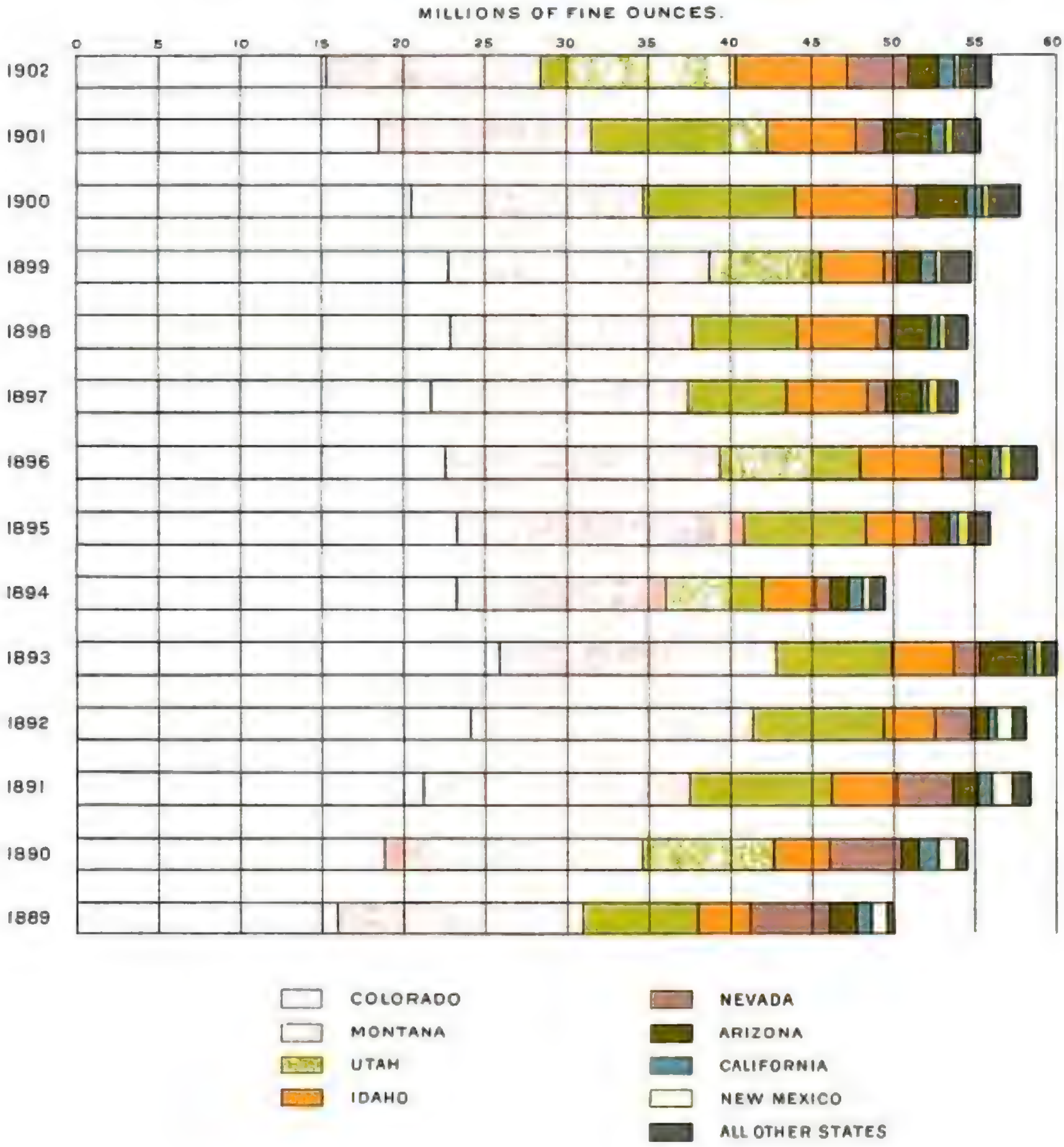
The majority of mine operators in California were interested in placer mines; measured by their output, however, the placer mines of California were of minor importance in comparison with the deep mines of the state. Small operators employing no hired labor were still very numerous in 1902 among the owners of placer mines. Reports were received from 316 mines operated without hired labor; each mine was worked on the average by two owners; the average value of product per mine was $924. Two-thirds of the product of this class of operators was obtained from placer mines. Where deep mines were worked without hired labor, only high-grade ore, averaging $25 per ton, was treated.

Most of the deep mines were equipped with mills for the treatment of their ores. Those which had no facilities for the treatment of their ores were very small, employing an average of about two men throughout the year; their annual production averaged only about $3,000 per mine. They treated only high-grade ore, averaging $24 per ton. Those mines which were provided with milling facilities were able to treat ores averaging $5 per ton; their annual production averaged $43,720 per mine.

There were among the operators 31 incorporated companies by which dividends were declared in 1902, aggregating $1,099,399, and averaging 4 per cent on the total outstanding capital stock. The ore treated by these companies was of a low grade, averaging only a little over $7 per ton. Their total production for 1902 was valued at $4,866,812, or an average of $156,994 per mine.

The tendency toward concentration of production was pronounced. Thirty-two of the operators, each with an output of $100,000 or over, produced more than one-

DIAGRAM IV.—PRODUCTION OF SILVER: 1889 TO 1902.



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half (52.8 per cent) of the total product, whereas all small producers (those whose output was less than $1,000, as well as those of a shifting character who made no individual reports) contributed in all 8.3 per cent of the total output of the state.

The tables which follow present the principal statistical facts for California. Table 72 is a comparative summary for deep mines with and without mill connection; arrastras, custom mills, and mines run exclusively on old tailings are not included in the comparison. Table 73 is a summary for placer mines, exclusive of 7 mines connected with stamp mills. Table 74 is a summary for 316 mines operated by the owners without hired labor, and Table 75 is a summary for dividend paying mines.

TABLE 72.—*Deep mines, with and without mill connections in California: 1902.*

	Deep mines without mill connection	Mines and mills reported jointly.	MINES AND MILLS REPORTED SEPARATELY.	
			Mines.	Mills.
Number of operators	151	134	112	
Salaried officials, clerks, etc.:				
Number	39	212	266	53
Salaries	$41,207	$304,849	$420,994	$73,403
Wage-earners:				
Average number	339	2,311	3,388	446
Wages	$311,318	$2,059,728	$3,123,477	$140,061
Contract work	$4,926	$16,958	$17,552	
Work on share of product	$25,869	$42,575	$51,790	
Miscellaneous expenses	$22,478	$243,235	$425,225	$70,361
Cost of supplies and materials	$101,411	$746,818	$1,253,955	$351,712
Crude ore shipped, short tons	22,415			
Ore treated, total, short tons		645,913		1,640,247
Mined and treated		636,394		1,637,978
Purchased ores				147
Custom ores		9,519		2,122
Value of bullion contents:				
Crude ore shipped—				
Gold	$467,671			
Silver	$64,376			
Other metals	$6,187			
Total	$538,234			
Average per ton	$24			
Treatment charges and freight	$91,656			
Value at mine	$446,578			
Ore treated—				
Gold		$3,487,910		$7,449,885
Silver		$42,152		$70,152
Other metals		$1,000		$1,670
Total		$3,531,062		$7,521,707
Average per ton		$6		$5
Treatment charges and freight		$111,207		$214,937
Value at mill		$3,419,855		$7,306,770
Amount received for custom work		$34,642		$13,897
Cost of purchased ore, including freight				$6,934
Total value of product at mill		$3,454,497		$7,313,733
Average per mine or mill	$2,957	$25,780		$65,301

TABLE 73.—*Summary for placer mines in California: 1902.*

Number of mines	547
Without hired labor	243
With hired labor	304
Number of owners working	673
Salaried officials, clerks, etc.	
Number	170
Salaries	$199,473
Wage earners:	
Average number	1,445
Wages	$1,114,513
Contract work	$7,630
Work on share of product	$35,804
Miscellaneous expenses	$200,518
Cost of supplies and materials	$468,183
Value of product at mine	$2,825,579

TABLE 74.—*Mines operated without hired labor in California: 1902.*

Number of mines	316
Number of owners working	674
Contract work	$610
Total miscellaneous expenses	$20,716
Rent and royalties—	
Mine and mineral lands	$11,208
Water	$1,728
Other	$4,505
Other miscellaneous expenses	$3,275
Cost of supplies and materials	$21,641
Product:	
Placer—	
Value at mine	$207,584
Deep—	
Tons sold or treated	3,861
Gross value of bullion contents	$95,259
Average per ton	$25
Charges for treatment and freight	$11,003
Value at mine	$84,256
Total value of product	$291,840
Average per mine	$924

TABLE 75.—*Summary for dividend paying productive mines in California: 1902.*

Number of mines	31
Par value of stock issued	$25,738,210
Dividends	$1,099,329
Salaries	$216,168
Wages	$1,628,891
Contract work	$7,218
Miscellaneous expenses	$232,284
Cost of supplies and materials	$693,272
Ore treated, short tons—	
Ore from mine	560,003
Purchased ores	147
Custom ores	7,722
Value of bullion contents:	
Ore from mine—	
Placer—	
Gold	$899,118
Silver	$395
Total gross value	$899,513
Treatment charges, including freight	$3,157
Value at mine	$896,356
Deep—	
Gold	$4,071,974
Silver	$38,545
Lead	$2,467
Total gross value	$4,112,986
Average per ton	$7
Treatment charges, including freight	$85,515
Value at mine	$4,036,602
Purchased ore, gold value	$9,131
Cost of purchased materials, including freight	$6,934
Amount received for custom work	$30,788
Total value of product	$4,866,812
Average per mine	$156,994

Colorado.—In 1902 Colorado was the principal gold and silver producing state. Only the largest mines had their own reduction works; their number was less than one-tenth of the total number of mines in the state, while their product amounted to over two-fifths of the total for the state. The average grade of ore treated at mills connected with mines was valued at $9 per ton, whereas the ore shipped from mines without mills of their own was worth $20 per ton.

About one-half of the mines without mill connections expended more during 1902 than the value of their product. The average value of their ore was the same as in other mines of the same class, viz, $20 per ton; the treatment charges and freight averaged with them $7.16 per ton, and with others $6.42 per ton. Apparently there was no difference, either in the grade of their ore or in their location, which would place them at a disadvantage as compared with other mines. It is therefore fair to assume that the surplus expenditure was invested in development work.

The leasing system is a prominent feature in Colorado. The total amount of royalties for mine and mineral lands reported by operators whose mines were located exclusively on leased land was $379,521, and the aggregate value of their product at the mines was $2,190,840. Thus the average rate of royalties was 17.3 per cent. The average production per mine in 1902 was valued at $11,352.

This number of lessees does not comprise the class of small operators locally known as "leasers," "block lessees," etc., and designated in this report as "share workers." Two-thirds of the total number of such operators in the United States, viz, 814 out of 1,230, were reported from Colorado. The total amount realized by them, after deducting royalties, was $1,106,602, making an average of $1,359 per "lease." A concise description of the system of mining on shares was furnished by Mr. Kenneth McKenzie, vice-president and general manager of the Acacia Gold Mining Company, Cripple Creek, Teller county, Colo., in a communication dated May 19, 1903, in reply to an inquiry from the Bureau of the Census. "There are generally from 2 to 6 men interested in a lease; some of them work out for wages and divide up their wages with their partners working on the leased ground until they find ore enough to pay expenses, which very often they never do. Many of the men would be working for half wages and an interest in the lease. All properties that are operated by lessees in the Cripple Creek district are worked much the same as ours."

There were 47 incorporated companies which declared dividends in 1902. The total amount of dividends paid by them was $3,689,444, averaging 5.2 per cent on the par value of an outstanding capital stock of $70,753,173. The total value of their product was $13,801,413—i. e., nearly one-half of the total product of the gold and silver mines of the state; the average per mine was $293,647. The ore mined by them was of a high grade, averaging $20 per ton.

The tendency toward concentration was quite pronounced in Colorado. Sixty-four mines each producing $100,000 or more contributed over four-fifths (80.4 per cent) of the output of the state; 279 operators each producing less than $1,000 contributed only three-tenths of 1 per cent; and 429 with a product ranging from $1,000 to $100,000 produced less than one-fifth.

The principal statistical data for Colorado are presented in Tables 76, 77, 78, and 79. Table 76 is a comparative summary of deep mines with and without mills; productive mines, and mines where the work was chiefly development, are shown in separate columns. Table 77 is a summary of deep mines operated on leased land only. Table 78 is a comparative summary of mines worked on shares with and without hired labor. Table 79 is a summary for dividend paying companies.

TABLE 76.—*Summary for deep mines with and without mills in Colorado: 1902.*

	DEEP MINES WITHOUT MILL CONNECTION.		Mines and mills reported jointly.	MINES AND MILLS REPORTED SEPARATELY.	
	Productive.	Developing and producing		Mines.	Mills.
Number of operators	351	312	30	34	
Salaried officials, clerks, etc.:					
Number	441	283	192	117	50
Salaries	$641,705	$332,966	$336,736	$156,591	$72,095
Wage-earners					
Average number	4,454	2,178	2,429	1,216	261
Wages	$4,732,276	$2,218,265	$2,620,908	$1,295,135	$292,620
Contract work	$171,062	$115,925	$39,003	$34,694	
Work on share of product	$875,379	$194,214	$36,979		
Miscellaneous expenses	$1,077,709	$276,908	$400,095	$131,356	$18,861
Cost of supplies and materials	$2,133,863	$1,111,352	$1,118,352	$441,870	$131,486
Crude ore shipped, tons	1,058,441	146,310	87,175		
Ore treated, total tons			596,038		490,190
Mined and treated			562,320		476,353
Custom ores			33,718		13,837
Value of bullion contents					
Crude ore shipped—					
Gold	$15,450,566	$2,353,347	$1,859,641		
Silver	$4,390,867	$473,959	$302,132		
Lead	$967,489	$100,051	$211,805		
Other metals	$436,648	$23,657	$202		
Total	$21,245,570	$2,951,014	$2,373,780		
Average per ton	$20	$20	$27		
Treatment charges and freight	$6,793,420	$1,048,262	$1,059,016		
Value at mine	$14,452,150	$1,902,752	$1,314,764		
Ore treated—					
Gold			$4,195,086		$2,170,256
Silver			$1,016,078		$961,593
Lead			$363,570		$184,328
Other metals			$226,137		$166,715
Total			$5,800,871		$3,482,894
Average per ton			$10		$7
Treatment charges and freight			$689,888		$402,800
Value at mill			$5,110,983		$3,080,094
Amount received for custom work			[1]$394,651		$23,314
Total value of product			$6,820,398		$3,103,408
Average per mine or mill	$41,174	$6,099	$227,347		$91,277

[1] Includes $251,797 charged by reduction works against their own mines and credited by the latter to their reduction works.

TABLE 77.—*Summary for deep mines operated on leased land only in Colorado: 1902.*

Number of mines	193
Number of owners working	93
Salaries	$119,603
Wages	$909,788
Contract work	$33,709
Work on share of product	$9,684
Rents and royalties of mines and mineral lands	$379,521
Other miscellaneous expenses	$66,572
Cost of supplies and materials	$380,694
Value of product at mine	$2,190,840
Average per mine	$11,352
Ore sold and treated, short tons	170,057
Value of bullion contents:	
Gold	$1,895,777
Silver	$792,113
Other metals	$430,677
Total gross value	$3,118,567
Average per ton	$18
Acreage leased	4,398
Average acreage per mine	23

TABLE 78.—*Summary for mines worked on shares in Colorado: 1902.*

	Total.	Without wage labor.	With wage labor.
Number of mines	157	127	30
Number of owners working	4	4	....
Salaries	$177,243	$17,824	$159,419
Wages	$841,282	....	$841,282
Contract work	$29,860	$8,520	$21,340
Share workers:			
Number	814	321	493
Amount paid	$1,106,602	$475,055	$631,547
Miscellaneous expenses	$212,340	$36,324	$176,016
Cost of supplies and materials	$423,826	$13,430	$410,396
Ore sold and treated, short tons	204,938	49,468	155,470
Value of bullion contents:			
Gold	$2,751,716	$609,284	$2,142,432
Silver	$1,066,680	$251,271	$815,409
Other metals	$202,496	$55,052	$147,444
Total gross value	$4,020,892	$915,607	$3,105,285
Average per ton	$20	$19	$20
Value of product at mine	$2,767,879	$616,041	$2,151,838
Average per mine	$17,630	$4,851	$107,592

TABLE 79.—*Summary for dividend paying productive mines in Colorado: 1902.*

Number of mines	47
Par value of stock issued	$70,753,173
Dividends	$3,699,444
Salaries	$576,379
Wages	$4,523,646
Contract work	$133,835
Work on share of product	$272,697
Miscellaneous expenses	$726,718
Cost of supplies and materials	$2,287,060
Ore treated, short tons	930,782
Value of bullion contents:	
Gold	$14,144,404
Silver	$3,063,608
Copper	$141,201
Lead	$901,379
Other metals	$343,270
Total gross value	$18,593,862
Average per ton	$20
Treatment charges and freight	$5,047,246
Value at mine	$13,546,616
Amount received for custom work	$254,797
Total value at mine	$13,801,413
Average per mine	$293,647

Idaho.—About one-half of the mines of Idaho were placers, viz, 127, of which number 53 were operated without hired labor. The number of owners working was 92, and the average number of wage-earners employed was 199. The total value of the product was $302,175, an average of $2,379 per mine.

One-half of the deep mines were equipped with mills. These were the larger mines, the production of which averaged over $100,000 per mine. The ore treated was of a low grade, averaging about $9 per ton. The mines without mills were of the small type, with an annual product averaging less than $10,000 per mine. The ore treated by them was of a very high grade, averaging $60 per ton.

There were 10 incorporated companies which paid dividends in 1902. The total amount of dividends paid was $880,271, which was equal to 7.9 per cent on an outstanding capital stock of $11,130,420. The ore treated by these companies was of an average value of $11 per ton. The average production per mine was $358,175.

Concentration of ownership has made greater progress in Idaho than in other states. Five-eighths, $5,123,859, of the total output was contributed by 6 operators, each having an output valued at more than $500,000; one-fifth, $1,648,164, was contributed by 6 operators, each with an output valued at from $100,000 to $500,000. Very small operators, producing less than $1,000, including those from whom no individual reports were received, contributed only 1.4 per cent.

The principal statistical data for Idaho are given in the tables which follow. Table 80 is a comparative summary for deep mines operated with and without mills; Table 81 is a summary for argentiferous lead mines; Table 82 is a summary for dividend paying productive mines.

TABLE 80.—*Summary for deep mines with and without mills in Idaho: 1902.*

	Deep mines without mill connection.	Mines and mills reported jointly.	MINES AND MILLS REPORTED SEPARATELY.	
			Mines.	Mills.
Number of operators	61	20	42	....
Salaried officials, clerks, etc.:				
Number	15	96	157	35
Salaries	$18,190	$169,205	$279,182	$45,894
Wage earners:				
Average number	183	1,148	1,633	202
Wages	$194,701	$1,339,588	$1,754,279	$232,812
Contract work	$15,171	$3,739	$17,156	....
Work on share of product	$2,455	....	....	....
Miscellaneous expenses	$20,622	$373,918	$191,544	$1,408
Cost of supplies and materials	$58,874	$869,113	$651,367	$123,161
Crude ore shipped, short tons	11,390	503	....	....
Ore treated, total, short tons	....	340,705	....	940,254
Mined and treated	....	340,705	....	939,979
Purchased ores	....	....	....	275
Value of bullion contents:				
Crude ore shipped—				
Gold	$45,330	$13	....	....
Silver	$355,353	$27,319	....	....
Lead	....	$23,113	....	....
Other metals	$286,671	....	....	....
Total	$687,354	$50,445	....	....
Average per ton	$60	[illegible]	....	....
Treatment charges and freight	$214,787	$14,876	....	....
Value at mine	$472,567	$35,569	....	....
Ore treated—				
Gold	....	$337,867	....	$645,779
Silver	....	$1,207,250	....	$1,962,745
Lead	....	$2,500,464	....	$4,320,068
Other metals	....	$631	....	$7,086
Total	....	$4,046,212	....	$6,935,678
Average per ton	....	$12	....	$7
Treatment charges and freight	....	$1,211,537	....	$2,592,641
Value at mill	....	$2,834,675	....	$4,343,037
Cost of purchased ores, including freight	....	....	....	$2,003
Total value of product	....	$2,870,244	....	$4,341,034
Average per mill or mine	$7,747	$143,512	....	$103,357

TABLE 81.—*Summary for argentiferous lead mines in Idaho: 1902.*

Number of mines	41
Salaries	$393,293
Wages	$2,788,970
Contract work	$21,929
Miscellaneous expenses	$517,371
Cost of supplies and materials	$1,146,189
Ore treated, short tons:	
Total	1,185,710
Ore from mine	1,179,378
Custom ores	6,332
Bullion contents of product mined:	
Gold, ounces	4,634
Silver, ounces	6,287,965
Lead, pounds	208,591,226
Gold, value	$95,753
Silver, value	$3,164,884
Lead, value	$7,122,835
Other metals, value	$9,397
Total gross value	$10,392,869
Average per ton	$8.81
Value at mine	$6,414,052
Amount received for custom work	$12,946
Total value of product	$6,426,998
Average per mine	$156,756

TABLE 82.—*Summary for dividend paying productive mines in Idaho: 1902.*

Number of mines	10
Par value of stock issued	$11,130,420
Dividends	$880,271
Salaries	$231,678
Wages	$1,398,538
Contract work	$21,929
Miscellaneous expenses	$371,320
Cost of supplies and materials	$606,064
Product	
Placer—	
Value at mine	$7,000
Deep—	
Ore mined and treated, short tons	500,670
Value of bullion contents—	
Gold	$336,350
Silver	$1,518,217
Lead	$3,707,701
Copper	$1,000
Total gross value	$5,563,268
Average per ton	$11
Treatment charges and freight	$1,988,522
Value at mine	$3,574,746
Total value of product	$3,581,746
Average per mine	$358,175

Nevada.—Nevada was at one time the principal silver mining state. The famous Comstock lode in the early days of its history furnished more than one-half of the total silver production of the United States. The flooding of the lower levels of the Comstock lode in 1886 reduced silver mining in Nevada to insignificant proportions at a time when the price of silver was nearly twice as high as in 1902. The technical progress of recent years, however, has made it possible to resume mining on the submerged levels even with the present low price of silver.

The bulk of the product mined in Nevada in 1902 was high-grade ore carrying gold and silver, and averaging $62 per ton; this ore was shipped in crude state. There were 16 mines provided with reduction plants where low-grade ore was treated.

There were 6 incorporated companies which declared dividends in 1902. The total dividends paid by them amounted to $77,602, which was equal to an average of 2.8 per cent on an outstanding capital stock with a par value of $2,748,000. The average production per mine for these companies was a little over $250,000; the ore treated by them was of a very high grade, averaging $73 per ton.

The working of the deeper mines in Nevada required a large investment of capital; hence the necessity of producing on a large scale. Three-fifths of the total yield for 1902 was produced by 5 operators, each with an output valued at $100,000 or over; the production of 1 of these 5 mines was worth over $1,000,000.

The principal statistical data for Nevada are presented in the following tables. Table 83 is a comparative summary for deep mines with and without mills, and Table 84 is a summary for dividend paying mines.

TABLE 83.—*Summary for deep mines with and without mills in Nevada: 1902.*

	Deep mines without mill connection.	Mines and mills reported jointly.	MINES AND MILLS REPORTED SEPARATELY.	
			Mines.	Mills.
Number of operators	61	7	9	9
Salaried officials, clerks, etc.:				
Number	69	24	19	8
Salaries	$95,886	$53,282	$27,675	$11,095
Wage-earners:				
Average number	471	270	188	56
Wages	$588,494	$228,755	$199,765	$61,851
Contract work	$4,650	$3,294	....	....
Work on share of product	$43,602	....	$2,000	....
Miscellaneous expenses	$121,554	$15,506	$21,391	$1,519
Cost of supplies and materials	$216,298	$143,943	$116,246	$63,140
Crude ore shipped, short tons	40,584	29	....	....
Ore treated, short tons	....	36,958	....	97,855
Value of bullion contents:				
Crude ore shipped—				
Gold	$1,028,884	$102	....	....
Silver	$1,435,090	$1,344	....	....
Other metals	$61,618	....	....	....
Total	$2,525,592	$1,446	....	....
Average per ton	$62	$50	....	....
Treatment charges and freight	$570,712	$816	....	....
Value at mine	$1,954,880	$630	....	....
Ore treated—				
Gold	....	$168,315	....	$443,067
Silver	....	$220,391	....	$79,966
Other metals	....	$2,117	....	$80
Total	....	$390,823	....	$523,113
Average per ton	....	$11	....	$5
Treatment charges and freight	....	$21,824	....	$11,413
Value at mill	....	$368,999	....	$511,700
Total value of product	$1,954,880	$369,629	....	$511,700
Average per mine or mill	$32,047	$52,804	....	$56,856

TABLE 84.—*Summary for dividend paying productive mines in Nevada: 1902.*

Number of mines	6
Par value of stock issued	$2,748,000
Dividends	$77,602
Salaries	$35,225
Wages	$233,125
Contract work	$3,294
Miscellaneous expenses	$47,153
Cost of supplies and materials	$16,704
Product:	
Placer—	
Value at mine	$4,510
Deep—	
Ore treated, short tons—	
Ore from mine	26,496
Custom ores	10,061
Value of bullion contents—	
Gold	$672,030
Silver	$1,219,649
Lead	$39,872
Other metals	$203
Total gross value	$1,931,754
Average per ton	$72.91
Treatment charges, including freight	$442,733
Value at mine	$1,489,021
Amount received for custom work	$25,153
Total value of product	$1,518,684
Average per mine	$252,862

The following is a tabular statement showing the production of the Comstock lode for 42 years, from its discovery in 1859 to the close of 1900.[1] The statistics for the earlier years are estimates based upon reports by locators and producers as substantiated by data given by millmen, and Wells, Fargo & Co., and by the county assessors' records. The results are thought to be substantially correct.

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[1] Prepared by Alfred W. Doten: Report of Director of the Mint on the Production of the Precious Metals, 1900, pages 162 and 163.

Comstock total gold and silver production, from discovery and commencement: 1859 to 1900.

YEAR	Ore (tons).	Gold, value.	Silver, value.	Total value.	Average per ton.
1859	....	$30,000.00	....	$30,000.00	....
1860	10,000	550,000.00	$200,000.00	750,000.00	$75
1861	140,000	2,500,000.00	1,000,000.00	3,500,000.00	25
1862	250,000	4,650,000.00	2,350,000.00	7,000,000.00	28
1863	450,000	4,940,000.00	7,460,000.00	12,400,000.00	28
1864	680,450	6,400,000.00	9,600,000.00	16,000,000.00	24
1865	430,745	6,133,488.00	9,700,232.00	15,833,720.00	37
1866	640,292	5,963,158.00	8,944,737.00	14,907,895.00	23
1867	462,176	5,495,443.20	8,243,164.80	13,738,608.00	30
1868	300,560	3,391,907.60	5,087,861.40	8,479,769.00	28
1869	279,584	2,962,231.20	4,443,346.80	7,405,578.00	26
1870	238,967	3,481,730.16	5,222,595.24	8,704,325.40	36
1871	409,718	4,099,811.46	6,149,717.19	10,249,528.65	25
1872	384,668	4,894,559.86	7,341,839.79	12,236,399.65	32
1873	448,301	8,668,793.40	13,003,187.13	21,671,980.53	48
1874	526,743	8,990,714.06	13,486,071.09	22,476,785.15	43
1875	546,425	10,330,208.62	15,495,312.92	25,825,521.54	47
1876	598,818	12,647,464.08	18,971,196.12	31,618,660.20	53
1877	562,519	14,520,614.68	21,780,922.02	36,301,536.70	65
1878	272,909	7,864,557.64	11,796,836.47	19,661,394.11	72
1879	178,276	2,801,394.33	4,202,091.49	7,003,485.82	39
1880	172,399	2,051,606.00	3,077,409.00	5,129,015.00	30
1881	76,049	430,248.00	645,372.00	1,075,620.00	14
1882	90,181	697,385.60	1,046,078.40	1,743,464.00	19
1883	125,914	802,339.54	1,203,509.29	2,005,848.83	16
1884	188,369	1,261,313.60	1,577,438.40	2,838,752.00	15
1885	226,147	1,729,531.25	1,415,071.04	3,144,602.29	14
1886	238,780	2,054,920.15	1,681,298.31	3,736,218.46	16
1887	223,082	2,481,176.85	2,030,053.78	4,511,230.63	20
1888	271,152	3,169,209.07	4,158,058.66	7,327,267.73	28
1889	280,144	2,500,973.32	3,358,949.95	5,859,923.27	21
1890	296,075	1,992,349.03	2,988,523.56	4,980,872.59	17
1891	188,647	1,380,857.02	2,071,285.53	3,452,142.55	18
1892	133,678	1,043,158.86	1,130,068.77	2,173,227.63	16
1893	109,780	1,123,262.51	748,841.70	1,872,104.21	17
1894	97,049	768,880.63	512,587.09	1,281,467.72	13
1895	63,558	548,873.68	365,915.79	914,789.47	14
1896	39,240	340,253.36	226,835.57	567,088.93	14
1897	17,850	223,808.63	149,205.76	373,014.39	21
1898	10,766	123,023.89	82,015.92	205,039.81	19
1899	6,780	103,006.74	68,671.16	171,677.90	25
1900	35,300	381,423.56	319,441.70	700,865.26	20
Total	10,028,681	146,613,877.61	203,636,062.84	350,249,940.45	....
Total mill tailings added	....	....	....	17,763,865.16	....
Grand total	....	....	....	368,013,805.61	....

As the above statement shows, the higher grade ores became exhausted by 1881, when the average value per ton fell by nearly one-half. There was a temporary increase in 1888 due to finds of rich ore. In 1900 the production seemed to be on the increase. The total production has been valued by some as high as $500,000,000. This lode has produced nearly as much gold as silver.

The statement below, drawn from the same source as the one preceding, shows the financial results of forty years' mining operations in the Comstock lode.[1] All the mines are arranged in three groups: (1) Those whose investments as represented by assessments were repaid by dividends. (2) Those whose dividends failed to repay assessments. (3) Those which paid no dividends.

Forty years' assessments and dividends of Comstock mines.

CLASSIFICATION OF MINES WITH REGARD TO ASSESSMENTS AND DIVIDENDS.	Number of mines.	Total assessments.	Total dividends.
Total	28	$79,045,097	$133,101,590
Dividends in excess of assessments	5	10,635,650	117,620,200
Dividends short of assessments	9	40,238,684	15,481,390
No dividends paid	14	28,170,763	....

The preceding statement brings out the fact that only 5 companies returned their investment with profit; 9 companies have paid dividends, not sufficient, however, to repay for the capital invested, while one-half of the Comstock companies never recovered the capital invested. That so much capital was found for investment in obviously unprofitable ventures is thus explained by Mr. Doten: "The regular assessments levied upon the nonpaying mines were paid with the utmost facility by the market itself, delinquent assessments being immediately added to the price of the stock, fortune-blinded dealers hardly knowing or caring how it was done or who paid it, and it is to this recklessness of stock speculations that many of their mines owe their very existence to-day."

WORLD'S PRODUCTION OF GOLD AND SILVER IN 1902.

Table 85 represents the world's production of refined gold and silver in 1902, as estimated by the Director of the Mint.

It shows that as a producer of gold the United States held the second rank, being preceded by Australasia; South Africa followed next, the fourth rank was held by Russia, and the fifth by Canada. Great Britain with her colonial empire produced, in round numbers, $154,000,000, or more than one-half of the total output of the world, and the United States followed next with $80,000,000, or more than one-fourth; both nations together contributed four-fifths of the product of the gold mines of the world.

Mexico was the leading silver producing country, the output of her mines exceeding one-third of the world's production; the United States followed close behind, with one-third of the world's output. North America contributed 71.9 per cent of the world's production, and Central and South America 14.1 per cent, making for the entire American continent six-sevenths of the silver product of the world.

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[1] Report of Director of the Mint on the Production of the Precious Metals, 1900, page 159.

TABLE 85.—WORLD'S PRODUCTION OF GOLD AND SILVER FOR THE CALENDAR YEAR 1902.

[Report of the Director of the Mint, "Production of Precious Metals," 1902.]

COUNTRY.	GOLD.			SILVER.			
	Kilograms (fine).	Ounces (fine).	Value.	Kilograms (fine).	Ounces (fine).	Coining value.	Commercial value.
Total	445,215	14,313,690	$295,889,600	5,193,978	166,955,639	$215,861,800	$88,486,500
North America:							
United States	120,373	3,870,000	80,000,000	1,726,208	55,500,000	71,757,600	29,415,000
Mexico	15,279	491,156	10,153,100	1,872,091	60,176,604	77,804,100	31,893,600
Canada	31,209	1,003,355	20,741,200	133,891	4,303,774	5,564,500	2,281,000
South America:							
Argentina	45	1,451	30,000	1,174	37,729	48,800	20,000
Bolivia	7	228	4,700	404,201	12,992,641	16,798,600	6,886,100
Brazil	3,001	96,488	1,994,600	....	....	....	....
Chile	866	27,825	575,200	110,962	3,566,792	4,611,600	1,890,100
Colombia	3,796	122,031	2,522,600	55,259	1,776,604	2,297,000	941,600
Ecuador	301	9,675	200,000	240	7,736	10,000	4,100
Guiana (British)	2,721	87,491	1,808,600	....	....	....	....
Guiana (Dutch)	484	15,577	322,000	....	....	....	....
Guiana (French)	3,642	117,077	2,420,200	....	....	....	....
Peru	3,500	112,525	2,326,100	132,668	4,264,528	5,513,700	2,260,200
Uruguay	87	2,796	57,800	24	755	1,000	400
Venezuela	653	20,985	433,800	58	1,867	2,400	1,000
Central America	3,012	96,842	2,001,900	30,217	971,820	1,255,800	514,800
Europe:							
Austria-Hungary	3,267	105,037	2,171,300	58,523	1,881,132	2,432,200	997,000
Finland	2	63	1,300	269	8,679	11,200	4,600
France	....	....	....	11,956	384,399	496,900	203,700
Germany	94	3,023	62,500	178,032	5,722,641	7,399,000	3,033,000
Great Britain	175	5,626	116,300	5,387	173,208	223,900	91,800
Greece	....	....	....	33,915	1,090,188	1,409,500	577,800
Italy	8	257	5,300	30,000	964,339	1,246,800	511,100
Norway	3	97	2,000	6,422	206,413	266,900	109,400
Portugal	2	63	1,300	118	3,773	4,900	2,000
Russia	33,905	1,090,063	22,533,400	4,937	158,679	205,200	84,100
Spain	15	494	10,200	115,113	3,700,189	4,784,100	1,961,100
Sweden	94	3,023	62,500	1,439	46,226	59,900	24,500
Turkey	46	1,480	30,600	14,949	480,566	621,300	254,700
Australasia	122,749	3,946,374	81,578,900	249,690	8,026,037	10,377,100	4,253,800
Africa	58,716	1,887,773	39,023,700	....	....	....	....
Asia:							
British India	14,428	463,824	9,588,100	....	....	....	....
China	13,138	422,401	8,731,800	....	....	....	....
East Indies (British)	1,545	49,686	1,027,100	....	....	....	....
East Indies (Dutch)	850	27,312	564,600	3,679	118,292	152,900	62,700
Japan	1,936	62,259	1,287,000	12,151	390,567	505,000	207,000
Korea	5,266	169,313	3,500,000	....	....	....	....

The following table shows the silver production of the mines and smelters of the world from 1889 to 1901. The mines of the United States and Mexico produce about two-thirds of the world's supply of silver. The United States smelts and refines all silver exported from Mexico and Canada and a portion of the production of Central and South America. Great Britain, Germany, and Belgium together import about one-half as much silver ore as the United States. The countries from which they draw their supply of ore are chiefly Australia and South America.

TABLE 86.—WORLD'S PRODUCTION OF SILVER FROM MINES AND SMELTERS: 1889 TO 1901.

[Figures for 1893 to 1901 from "Lead, Copper, Spelter, Tin, Silver, Nickel, Aluminum, and Quicksilver," compiled by Metallgesellschaft and Metallurgische Gesellschaft, A.-G., Frankfort-on-the-Main, October, 1902; those for 1889 to 1892 from "Summary of the Statistical Report of the Metallgesellschaft."]

[Metric tons.]

COUNTRY.	1901				1900				1899			
	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.
Total production	5,511.6	5,444.1	2,124.7	2,057.2	5,613.0	5,400.3	2,251.2	2,038.5	5,277.0	5,237.1	1,967.5	1,927.6
Europe	1,134.6	438.6	749.2	53.2	1,114.0	421.6	729.4	37.0	1,140.8	428.1	752.9	40.2
Germany	403.8	171.8	232.0		415.7	168.4	247.3		467.6	194.2	273.4	
Great Britain	283.9	6.9	277.0		266.0	6.9	259.1		275.0	5.8	269.2	
Belgium	167.0		167.0		143.0		143.0		120.9		120.9	
Spain and Portugal	95.0	99.2		4.2	99.9	99.2	0.7		88.4	76.4	12.0	
France	77.5	14.1	63.4		85.6	14.1	71.5		82.1	14.5	67.6	
Austria-Hungary	62.8	62.1	0.7		59.8	61.9		2.1	60.6	59.0	1.6	
Italy	32.5	23.4	9.1		31.2	23.4	7.8		33.6	25.5	8.1	
Greece		35.9		35.9		31.5		31.5		36.7		36.7
Turkey	1.5	13.4		11.9	1.5	4.4		2.9	1.5	4.4		2.9
Norway	4.0	5.2		1.2	5.0	5.4		0.4	4.6	4.5	0.1	
Russia	4.9	4.9			4.4	4.5		0.1	4.2	4.2		
Sweden	1.7	1.7			1.9	1.9			2.3	2.3		
Servia										0.6		0.6
America	4,138.0	4,543.2	1,370.3	1,775.5	4,260.0	4,507.4	1,516.6	1,764.0	3,915.0	4,359.8	1,211.3	1,656.1
United States	3,088.0	1,717.7	1,370.3		3,310.0	1,793.4	1,516.6		2,915.0	1,703.7	1,211.3	
Mexico	750.0	1,793.7		1,043.7	650.0	1,786.9		1,136.9	700.0	1,730.1		1,030.1
Central and South America	300.0	868.7		568.7	300.0	788.7		488.7	300.0	819.9		519.9
Canada		163.1		163.1		138.4		138.4		106.1		106.1
Australia	180.0	406.0		226.0	180.0	415.0		235.0	165.0	396.3		231.3
Japan	59.0	53.8	5.2		59.0	53.8	5.2		56.2	52.9	3.3	
East Indies		2.5		2.5		2.5		2.5				

COUNTRY.	1898				1897				1896			
	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.
Total production	5,324.1	5,259.3	1,978.0	1,913.2	5,360.6	4,990.6	2,049.0	1,679.0	5,258.3	4,886.2	1,658.4	1,286.3
Europe	1,215.6	415.1	846.6	46.1	1,240.2	408.9	873.3	42.0	1,076.8	528.6	674.5	126.3
Germany	480.6	173.3	307.3		448.0	171.0	277.0		428.4	183.3	245.1	
Great Britain	310.0	6.6	303.4		375.0	7.2	367.8		310.0	8.2	301.8	
Belgium	100.6		100.6		75.7		75.7		59.4		59.4	
Spain and Portugal	114.0	76.4	37.6		131.0	71.2	59.8		92.0	179.8		87.8
France	90.9	14.3	76.6		80.4	16.9	63.5		70.5	16.4	54.1	
Austria-Hungary	59.1	56.4	2.7		66.8	61.3	5.5		59.7	58.0	1.7	
Italy	43.4	25.0	18.4		45.3	22.9	22.4		38.1	27.2	10.9	
Greece		42.0		42.0		37.4		37.4		32.0		32.0
Turkey	1.5	4.4		2.9	1.5	4.4		2.9	1.5	7.0		5.5
Norway	4.8	5.4		0.6	5.4	6.5		1.1	4.7	5.0		0.3
Russia	8.7	8.7			8.9	8.9			10.4	10.5		0.1
Sweden	2.0	2.0			2.2	0.6	1.6		2.1	0.6	1.5	
Servia		0.6		0.6		0.6		0.6		0.6		0.6
America	3,875.0	4,457.2	1,131.4	1,713.6	3,850.0	4,157.8	1,174.4	1,482.2	3,864.0	3,912.6	983.7	1,032.3
United States	2,825.0	1,693.6	1,131.4		2,850.0	1,675.6	1,174.4		2,834.0	1,850.3	983.7	
Mexico	750.0	1,765.1		1,015.1	700.0	1,677.0		977.0	730.0	1,402.3		672.3
Central and South America	300.0	860.0		560.0	300.0	632.3		332.3	300.0	560.3		260.3
Canada		138.5		138.5		172.9		172.9		99.7		99.7
Australia	173.0	331.4		158.4	214.7	369.5		154.8	253.0	380.7		127.7
Japan	60.5	60.6		0.1	55.7	54.4	1.3		64.5	64.3	0.2	
East Indies												

TABLE 86.—WORLD'S PRODUCTION OF SILVER FROM MINES AND SMELTERS: 1889 TO 1901—Continued.

COUNTRY.	1895				1894				1893			
	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.
Total production	5,233.2	5,210.9	1,519.6	1,497.3	5,509.5	5,121.0	1,641.5	1,253.0	5,434.5	5,147.8	1,475.6	1,188.9
Europe	1,156.2	454.0	781.2	79.0	1,429.2	456.1	1,033.7	60.6	1,397.1	494.0	939.0	35.9
Germany	392.0	181.0	211.0		444.2	193.0	251.2		449.3	179.0	270.3	
Great Britain	420.0	8.7	411.3		600.0	7.9	592.1		600.0	7.9	592.1	
Belgium	66.9		66.9		67.0		67.0		62.7		62.7	
Spain and Portugal	83.0	109.8		26.8	85.0	63.6	21.4		62.6	62.6		
France	71.1	17.6	53.5		97.0	26.1	70.9		98.1	98.1		
Austria-Hungary	60.5	67.9		7.4	58.3	83.5		25.2	61.2	90.1		28.9
Italy	44.2	5.7	38.5		58.6	28.9	29.7		40.1	28.9	11.2	
Greece		35.4		35.4		35.4		35.4		2.0		2.0
Turkey	1.5	8.1		6.6	1.5	1.5			1.3	6.3		5.0
Norway	5.0	6.1		1.1	4.8	4.7	0.1		4.8	4.5	0.3	
Russia	10.8	12.5		1.7	9.9	8.6	1.3		12.5	10.1	2.4	
Sweden	1.2	1.2			2.9	2.9			4.5	4.5		
Servia												
America	3,767.0	4,300.4	733.3	1,266.7	3,798.1	4,041.7	596.5	840.1	3,781.0	3,958.0	525.2	702.2
United States	2,467.0	1,733.7	733.3		2,136.4	1,539.9	596.5		2,391.8	1,866.6	525.2	
Mexico	800.0	1,461.0		661.0	1,161.7	1,463.4		301.7	889.2	1,380.1		490.9
Central and South America	500.0	1,050.5		550.5	500.0	1,012.0		512.0	500.0	703.6		203.6
Canada		55.2		55.2		26.4		26.4		7.7		7.7
Australia	237.5	389.1		151.6	210.0	562.3		352.3	187.0	637.8		450.8
Japan	72.5	67.4	5.1		72.2	60.9	11.3		69.4	58.0	11.4	
East Indies												

COUNTRY.	1892				1891				1890				1889			
	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.	Product of smelters.	Product of mines.	Excess of product of smelters over mines.	Excess of product of mines over smelters.
Total production	5,158.0	4,757.7	1,264.8	864.5	4,805.0	4,267.8	1,207.8	670.6	4,383.7	4,144.1	918.0	678.4	4,175.5	3,900.9	903.5	628.9
Europe	1,362.6	478.6	896.0	12.1	1,340.5	424.4	924.1	8.0	1,086.7	400.5	692.7	6.5	1,082.2	409.2	673.0	
Germany	487.8	212.1	275.7		444.9	186.6	258.3		402.9	182.1	220.8		403.0	192.8	210.2	
Great Britain	540.0	5.3	534.7		600.0	6.1	593.9		400.0	9.1	390.9		380.0	9.5	370.5	
Belgium	57.0		57.0		56.0		56.0		54.0		54.0		42.6		42.6	
Spain and Portugal	55.7	46.3	9.4		51.5	46.3	5.2		46.0	51.5		5.5	65.0	51.5	13.5	
France	103.2	92.7	10.5		71.3	64.2	7.1		71.1	71.1			80.9	80.9		
Austria-Hungary	55.0	55.1		0.1	53.0	52.0	1.0		53.0	50.6	2.4		52.6	52.6		
Italy	43.0	39.8	3.2		37.6	37.6			34.4	10.1	24.3		33.5	8.1	25.4	
Greece		2.0		2.0		2.0		2.0								
Turkey	1.3	6.3		5.0	1.3	6.3		5.0	1.3	1.3			1.3	1.3		
Norway	4.8	4.5	0.3		4.7	5.7		1.0	5.0	5.5		0.5	5.3	5.1	0.2	
Russia	9.5	14.5		5.0	14.5	13.9	0.6		14.5	15.0		0.5	13.8	3.2	10.6	
Sweden	5.2		5.2		5.7	3.7	2.0		4.5	4.2	0.3		4.2	4.2		
Servia																
America	3,684.8	3,806.0	368.8	490.0	3,376.0	3,489.0	283.7	396.7	3,192.6	3,442.9	214.9	465.2	3,050.3	3,244.2	230.5	424.4
United States	2,344.3	1,975.5	368.8		2,098.3	1,814.6	283.7		1,910.4	1,695.5	214.9		1,785.9	1,555.4	230.5	
Mexico	840.5	1,228.9		388.4	777.7	1,084.1		306.4	832.2	1,211.6		379.4	814.4	1,143.9		329.5
Central and South America	500.0	590.9		90.9	500.0	580.5		80.5	450.0	523.3		73.3	450.0	533.0		83.0
Canada		10.7		10.7		9.8		9.8		12.5		12.5		11.9		11.9
Australia	75.0	418.1		343.1	45.5	311.1		265.6	51.5	258.2		206.7		204.5		204.5
Japan	35.7	55.0		19.3	43.0	43.3		0.3	52.9	42.5	10.4		43.0	43.0		
East Indies																

PRODUCTION OF LEAD.

Lead contents of ores smelted in the United States, 1894 to 1902.—A considerable part of the value of the total output of silver mines is the value of the lead contents of their ores. In many cases the value of the lead contained determines whether or not an ore can be mined with profit; and, therefore, statistics of lead are of direct interest in connection with silver.

About three-fourths of the entire output of refined lead in the United States is obtained from silver bearing ores, as appears from the following table. The ores of Missouri, Kansas, Wisconsin, Illinois, Iowa, Virginia, and Kentucky are nonargentiferous; all others are argentiferous.

TABLE 87.—LEAD CONTENTS OF ORES SMELTED BY THE WORKS IN THE UNITED STATES, BY STATES AND TERRITORIES: 1894 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Short tons.]

STATE OR TERRITORY.	1902	1901	1900	1899	1898	1897	1896	1895	1894
Total lead contents American ores smelted	280,797	284,204	....	230,090	235,573	222,499	197,496	182,331	170,383
Colorado	51,833	73,265	82,137	70,308	57,352	40,576	44,803	46,984	50,613
Idaho	84,742	79,654	86,444	52,154	59,142	58,627	46,662	31,638	33,308
Utah	53,914	49,870	48,044	29,987	39,299	40,537	35,578	31,305	23,190
Montana	4,438	5,791	....	10,227	10,745	12,930	11,070	9,802	9,637
New Mexico	741	1,124	....	4,856	5,797	9,123	3,461	3,040	2,973
Nevada	1,269	1,873	....	3,388	4,714	959	1,173	2,583	2,254
Arizona	599	4,045	....	3,377	2,224	2,184	1,165	2,053	1,480
California	175	381	520	187	482	383	691	949	478
Washington	1,457	1,029	....	862	1,349	638	1,006	381	150
Oregon, Alaska, South Dakota, Texas	2,184								
Missouri, Kansas, Wisconsin, Illinois, Iowa, Virginia, and Kentucky	79,445	67,172	....	54,444	54,469	56,542	51,887	53,596	46,300

World's production and consumption of lead, 1889 to 1902.—The following table shows the world's production and consumption of lead, by countries, from 1889 to 1902:

TABLE 88.—WORLD'S PRODUCTION AND CONSUMPTION OF LEAD: 1889 TO 1902.

[Production figures from "Lead, Copper, Spelter, Tin, Silver, Nickel, Aluminum, and Quicksilver," compiled by Metallgesellschaft and Metallurgische Gesellschaft A. G., Frankfort-on-the-Main, October, 1903. Consumption figures from 1889 and 1892 from "Summary of the Statistical Report of the Metallgesellschaft;" those for 1893 to 1902 from "Metallgesellschaft and Metallurgische Gesellschaft," October, 1903.]

[Metric tons.]

COUNTRY.	1902				1901				1900			
	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.
Total	863,300	859,026	369,226	373,500	839,000	832,721	350,000	356,279	833,400	834,593	353,428	352,150
North America:												
United States	242,700	267,675	24,975	....	245,600	257,351	11,751	....	251,000	264,223	13,223	....
Mexico[1]	102,000	....	....	102,000	89,300	....	....	89,300	90,500	....	....	90,500
Canada[2]	8,900	....	....	8,900	23,700	....	....	23,700	19,200	....	....	19,200
Europe:												
Spain	172,200	....	....	172,200	149,500	....	....	149,500	154,500	....	....	154,500
Germany	140,300	156,237	15,937	....	123,100	155,164	32,064	....	121,500	172,855	51,440	....
Great Britain	27,100	238,214	211,114	....	35,600	225,602	190,002	....	35,500	202,855	167,355	....
Italy	26,400	28,273	1,873	....	26,200	24,621	....	1,579	23,800	22,150	....	1,650
Belgium	19,500	22,500	3,000	....	19,500	20,900	1,400	....	16,400	23,000	6,600	....
France	18,500	84,386	65,886	....	20,000	85,636	65,636	....	17,000	94,254	77,254	....
Greece	15,900	....	....	15,900	17,700	....	....	17,700	16,800	....	....	16,800
Austria-Hungary	12,500	21,153	8,653	....	12,200	22,877	10,677	....	12,700	20,286	7,586	....
Russia	....	23,300	23,300	....	....	23,000	23,000	....	....	20,300	20,300	....
Netherlands	....	5,000	5,000	....	....	5,000	5,000	....	....	5,000	5,000	....
Switzerland	....	3,288	3,288	....	....	3,470	3,470	....	....	3,170	3,170	....
Other European countries[3]	4,900	2,700	....	2,200	4,300	1,800	....	2,500	4,500	2,000	....	2,500
Australia[4]	72,300	....	....	72,300	72,000	....	....	72,000	67,000	....	....	67,000
All other countries[5]	100	6,300	6,200	....	300	7,300	7,000	....	3,000	4,500	1,500	....

COUNTRY.	1899				1898				1897			
	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.
Total	783,600	778,446	340,946	346,100	797,700	783,719	325,815	339,796	702,000	709,912	307,416	299,504
North America:												
United States	197,000	216,406	19,406	....	207,300	218,628	11,328	....	179,400	207,617	28,217	....
Mexico[1]	86,500	....	....	86,500	70,600	....	....	70,600	69,900	....	....	69,900
Canada[2]	8,100	....	....	8,100	15,000	....	....	15,000	17,000	....	....	17,000
Europe:												
Spain	162,900	....	....	162,900	180,500	....	....	180,500	171,700	....	....	171,700
Germany	129,200	160,369	31,169	....	132,700	155,372	22,672	....	118,900	129,898	10,998	....
Great Britain	42,000	205,444	163,444	....	50,000	212,163	162,163	....	40,000	182,384	142,384	....
Italy	20,500	22,036	1,536	....	24,500	20,104	....	4,396	22,400	20,796	....	1,604
Belgium	15,700	20,700	5,000	....	19,300	20,700	1,400	....	17,000	20,400	3,400	....
France	16,900	93,286	76,386	....	10,900	91,423	80,523	....	9,900	86,739	76,839	....
Greece	18,400	....	....	18,400	19,200	....	....	19,200	16,000	....	....	16,000
Austria-Hungary	11,900	20,605	8,705	....	12,600	22,038	9,438	....	12,200	18,038	5,838	....
Russia	....	23,300	23,300	....	....	22,650	22,650	....	....	24,750	24,750	....
Netherlands	....	5,000	5,000	....	....	5,000	5,000	....	....	5,000	5,000	....
Switzerland	....	2,700	2,700	....	....	3,441	3,441	....	....	2,640	2,640	....
Other European countries[3]	4,300	2,100	....	2,200	3,800	3,700	....	100	3,600	2,300	....	1,300
Australia[4]	68,000	....	....	68,000	50,000	....	....	50,000	22,000	....	....	22,000
All other countries[5]	2,200	6,500	4,300	....	1,300	8,500	7,200	....	2,000	9,400	7,400	....

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[1] For production, includes lead contents of the ores exported.

[2] For production, the figures comprise the lead obtained from Canada ores in the United States, as well as the Canadian exports of argentiferous lead which were not imported till 1900, in which year, however, the amount rose to 10,000 tons for 1901 and 1902 no figures were obtainable.

[3] For production, Russia, Scandinavia, and Turkey.

[4] For production, such as was not exported to Europe and America has not been taken into account here. The total production of Australia amounted in 1902 to 90,000; 1901 to 90,000; 1900, to 87,100; 1899, to 87,600; and in 1898, to about 67,000 metric tons. The exports of lead from Australia to eastern Asia amounted to about 11,700 in 1902, 9,100 in 1901, and 12,500 metric tons in 1900.

[5] For production, imports from Chile, Peru, East India, and Africa to Europe, according to European Trade Statistics.

TABLE 88.—WORLD'S PRODUCTION AND CONSUMPTION OF LEAD: 1889 TO 1902—Continued.

COUNTRY.	1896				1895				1894			
	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.
Total	677,100	675,889	286,056	287,267	638,000	656,851	303,705	284,854	621,800	629,877	289,399	281,322
North America:												
United States	158,500	179,801	21,301	....	142,300	214,459	72,159	....	146,400	173,413	27,013	....
Mexico[1]	63,300	....	....	63,300	68,000	....	....	68,000	57,000	....	....	57,000
Canada[2]	9,000	....	....	9,000	4,300	....	....	4,300	....	....	....	....
Europe:												
Spain	168,600	....	....	168,600	154,500	....	....	154,500	159,300	....	....	159,300
Germany	113,800	121,980	8,180	....	111,000	111,652	652	....	101,000	100,678	....	322
Great Britain	57,200	196,200	139,000	....	45,500	170,130	124,630	....	39,700	161,847	122,147	....
Italy	20,800	20,533	....	267	20,400	19,146	....	1,254	19,600	19,947	347	....
Belgium	17,200	18,800	1,600	....	15,600	17,094	1,494	....	14,100	22,478	8,378	....
France	8,200	77,776	69,576	....	7,600	64,657	57,057	....	8,800	86,160	77,360	....
Greece	14,700	....	....	14,700	16,800	....	....	16,800	12,700	....	....	12,700
Austria-Hungary	11,700	18,814	7,114	....	10,400	19,276	8,876	....	9,700	18,442	8,742	....
Russia	....	20,300	20,300	....	....	21,400	21,400	....	....	26,700	26,700	....
Netherlands	....	5,000	5,000	....	....	5,000	5,000	....	....	5,000	5,000	....
Switzerland	....	2,485	2,485	....	....	1,837	1,837	....	....	1,412	1,412	....
Other European countries[3]	3,500	2,100	....	1,400	3,600	1,600	....	2,000	3,500	1,500	....	2,000
Australia[4]	30,000	....	....	30,000	38,000	....	....	38,000	50,000	....	....	50,000
All other countries[5]	600	12,100	11,500	....	....	10,600	10,600	....	....	12,300	12,300	....

COUNTRY.	1893				1892				1891			
	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.
Total	627,600	635,732	301,761	293,629	629,200	634,530	282,935	277,605	598,800	619,760	272,892	251,932
North America:												
United States	151,700	179,163	27,463	....	166,200	191,728	25,528	....	160,800	181,842	21,042	....
Mexico[1]	64,000	....	....	64,000	47,500	....	....	47,500	30,200	....	....	30,200
Canada[2]	....	....	....	....	....	....	....	....	....	....	....	....
Europe:												
Spain	157,100	....	....	157,100	153,300	....	....	153,300	145,700	....	....	145,700
Germany	95,000	94,571	....	429	98,000	89,595	....	8,405	95,000	88,268	....	6,732
Great Britain	36,300	178,415	142,115	....	42,800	174,974	132,174	....	48,200	175,851	127,651	....
Italy	19,900	19,985	85	....	22,000	22,787	787	....	18,500	22,552	4,052	....
Belgium	12,000	23,088	11,088	....	10,100	13,779	3,679	....	12,700	19,834	7,134	....
France	8,100	77,065	68,965	....	8,800	73,545	64,745	....	6,700	70,664	63,964	....
Greece	12,800	....	....	12,800	14,400	....	....	14,400	13,300	....	....	13,300
Austria-Hungary	9,700	15,604	5,904	....	9,600	16,600	7,000	....	9,700	14,011	4,311	....
Russia	....	24,500	24,500	....	....	22,100	22,100	....	....	17,400	17,400	....
Netherlands	....	5,000	5,000	....	....	5,000	5,000	....	....	5,000	5,000	....
Switzerland	....	1,941	1,941	....	....	1,922	1,922	....	....	1,738	1,738	....
Other European countries[3]	3,000	1,700	....	1,300	2,500	2,700	200	....	2,000	2,800	800	....
Australia[4]	58,000	....	....	58,000	54,000	....	....	54,000	56,000	....	....	56,000
All other countries[5]	....	14,700	14,700	....	....	19,800	19,800	....	....	20,300	20,300	....

COUNTRY.	1890				1889			
	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.	Production.	Consumption.	Excess of consumption over production.	Excess of production over consumption.
Total	539,500	569,048	265,416	235,868	549,200	570,199	256,579	235,580
North America:								
United States	129,300	154,823	25,523	....	143,200	167,758	24,558	....
Mexico[1]	22,300	....	....	22,300	27,500	....	....	27,500
Canada[2]	....	....	....	....	....	....	....	....
Europe:								
Spain	140,300	....	....	140,300	136,900	....	....	136,900
Germany	101,000	82,432	....	18,568	100,400	77,820	....	22,580
Great Britain	48,500	159,832	111,332	....	47,600	153,087	105,487	....
Italy	17,700	19,733	2,033	....	18,200	23,837	5,637	....
Belgium	9,600	19,738	10,138	....	9,400	19,712	10,312	....
France	4,600	62,352	57,752	....	5,400	57,510	52,110	....
Greece	14,200	....	....	14,200	13,500	....	....	13,500
Austria-Hungary	9,500	12,785	3,285	....	10,500	13,275	2,775	....
Russia	....	18,800	18,800	....	....	16,000	16,000	....
Netherlands	....	5,000	5,000	....	....	5,000	5,000	....
Switzerland	....	2,753	2,753	....	....	2,400	2,400	....
Other European countries[3]	2,000	2,200	200	....	2,000	3,500	1,500	....
Australia[4]	40,500	....	....	40,500	35,000	....	....	35,000
All other countries[5]	....	28,600	28,600	....	....	30,800	30,800	....

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[1] For production, includes lead contents of the ores exported.

[2] For production, the figures comprise the lead obtained from Canada ores in the United States, as well as the Canadian exports of argentiferous lead which were not imported till 1900, in which year, however, the amount rose to 10,000 tons; for 1901 and 1902 no figures were obtainable.

[3] For production, Russia, Scandinavia, and Turkey.

[4] For production, such as was not exported to Europe and America has not been taken into account here. The total production of Australia amounted in 1902 to 90,000; 1901, to 90,000; 1900, to 87,100; 1899, to 87,600; and in 1898, to about 67,000 metric tons. The exports of lead from Australia to eastern Asia amounted to about 11,700 in 1902, 9,100 in 1901, and 12,500 metric tons in 1900.

[5] For production, imports from Chile, Peru, East India, and Africa to Europe, according to European Trade Statistics.

DIAGRAM V.—VARIATION OF THE COMMERCIAL RATIO OF SILVER TO GOLD SINCE 1700.

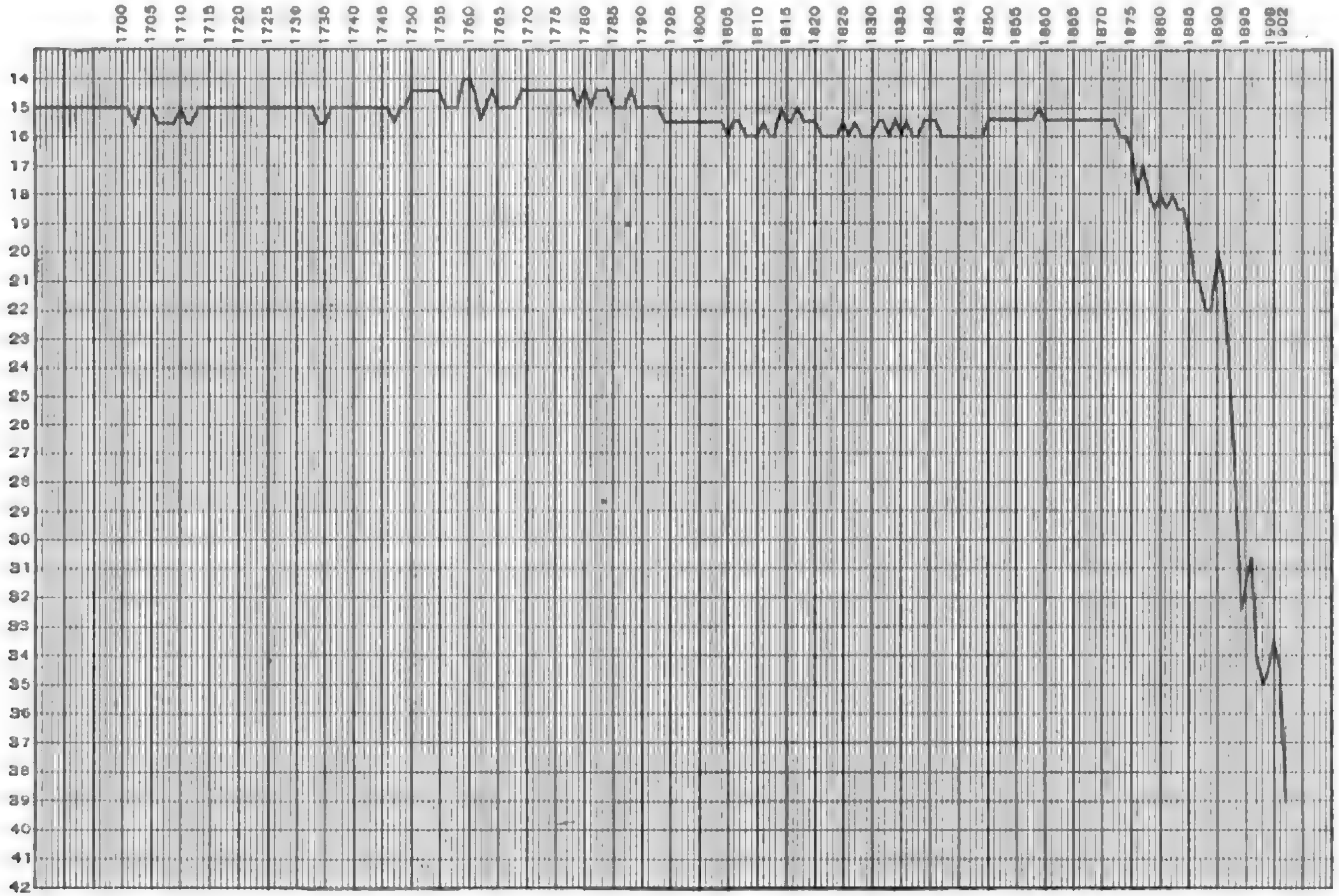


DIAGRAM VI.—PRICES OF SILVER AND LEAD IN THE LONDON MARKET: 1843 TO 1872.

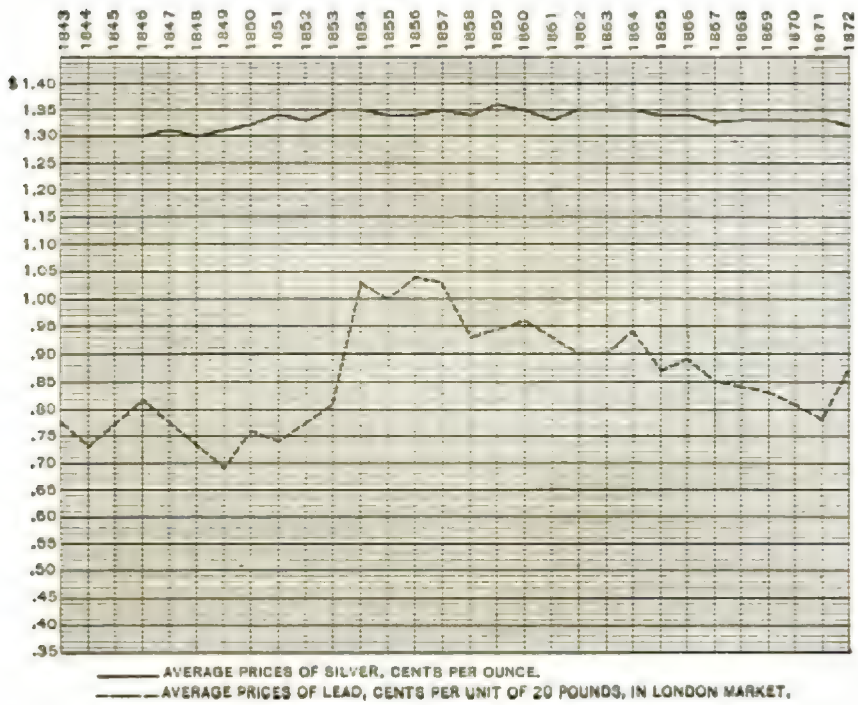
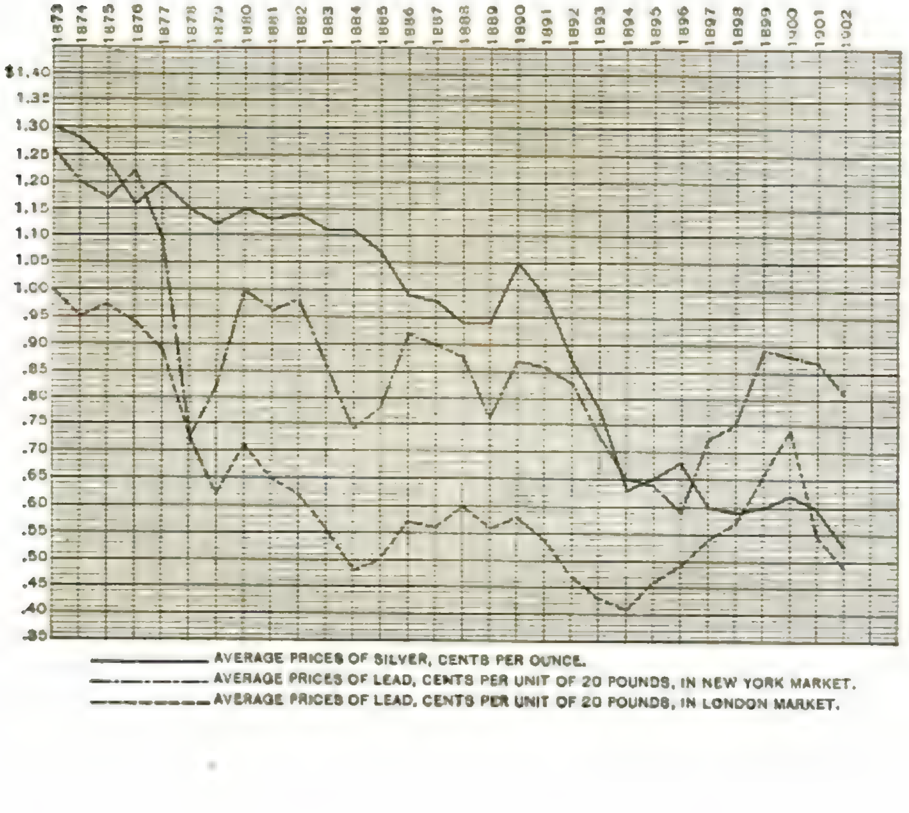


DIAGRAM VII.—PRICES OF SILVER AND LEAD IN THE LONDON MARKET, AND LEAD IN THE NEW YORK MARKET: 1873 TO 1902.



The foregoing table shows that the United States is both the largest producer and the largest consumer of lead. Spain, Germany, Mexico, and Australia, respectively, rank next as producers, while Great Britain, Germany, and France follow in this order as consumers. More than one-half of the world's lead output is consumed in the lead producing countries, less than one-half being an article of international commerce. The largest producer for the world's market is Spain, which furnished in 1902 about one-half of the supply; next after Spain follows Mexico, and the third place is occupied by Australia. These three countries together furnish the supply for about nine-tenths of the international demand for lead. The largest consumer of imported lead is Great Britain, which in 1902 consumed more than one-half of the international supply. The second place is held by France. The two countries together have imported within late years from two-thirds to three-fourths of the entire quantity sold in the world's market. The United States produces lead for home consumption only, and imports a comparatively small proportion for the same purpose; but a considerable quantity of lead ores and base bullion is imported from Mexico and British America, refined in bond, and reexported.

The following table shows, by years, the share of the United States in the lead exports of Mexico and British America. The first column represents the excess of the product of Mexico and British America over their consumption, as shown in the preceding table, the quantities being reduced from metric to short tons. The second column represents the production of refined lead in the United States from foreign ores and base bullion, less the imports of ore and base bullion from other countries than the two above named; both quantities are taken from the estimates of the United States Geological Survey.

TABLE 89.—*Total exports of lead ore and base bullion from Mexico and British America, and exports from those countries to the United States: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	TOTAL EXPORTS.	EXPORTS TO THE UNITED STATES.	
	Short tons.	Short tons	Per cent of total exports.
1902	122,212	98,008	80.2
1901	124,526	108,281	87.0
1900	120,869	103,281	85.4
1899	104,249	95,355	91.5
1898	94,331	99,705	105.7
1897	95,764	82,891	86.6
1896	79,675	76,910	96.5
1895	79,675	75,707	95.0
1894	62,814	59,739	95.1
1893	70,529	65,351	92.7
1892	52,345	39,957	76.3
1891	33,280	23,852	71.7
1890	24,575	18,121	73.7
1889	30,305	26,570	87.7

The preceding table shows that the United States received about nine-tenths of the exports from Mexico and British America. In 1898 the lead product smelted in the United States from Mexican and Canadian ores exceeded the total exports from those countries; this is explained by the fact that a portion of the ore smelted during that year had been exported during the year previous.

Prices of silver and lead.—Diagram V shows the annual fluctuations of the commercial ratio of gold to silver since the beginning of the eighteenth century. The fluctuations in the price of an ounce of standard silver, 0.925 fine, in the London market in 1901 and 1902 are shown in the following statement:[1]

Prices of silver in London by months: 1902 and 1901.

	1902	1901
	d	d
January	25.69	28.98
February	25.42	28.14
March	25.01	27.94
April	24.32	27.30
May	23.70	27.45
June	24.17	27.42
July	24.38	26.96
August	24.23	26.94
September	23.88	26.96
October	23.40	26.61
November	22.69	26.09
December	22.21	25.44

Diagrams VI and VII show the fluctuations of the prices of silver and lead for two periods of equal length divided by the year 1873, when silver began to decline in value. Diagram VI shows the prices in the London market of an ounce of fine silver and of a unit of 20 pounds of lead. Diagram VII shows the London prices of silver and lead and the New York price of lead since 1873.

An examination of the diagrams shows that the prices of lead and silver move in different directions: though the bulk of silver as well as of lead in the United States is smelted from ores where both metals occur together, yet their price movements in the United States show no similarity; on the other hand, the movements of the London and the New York price of lead are approximately parallel.

Tables 90 and 91 are detailed summaries of the statistics for gold and silver mines for 1902, the former for producing mines, the latter for mines at which the work was only development.

DESCRIPTIVE.

The production of gold and silver antedates the dawn of written history. The search for the precious metals prompted the discovery of new continents and stimulated the efforts of the alchemists, thus indirectly leading to the development of scientific chemistry. Yet it is only since the beginning of gold mining in English-speaking countries, at about the middle of the nineteenth century, that any progress in mining methods can be recorded. And even to-day, notwithstanding the technical advance of the last half century, mining methods of primitive man can be observed in actual operation in some parts of the United States.

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[1] "Comparative Statistics of Lead, Copper, Spelter, Tin, Silver, Nickel, Aluminum, and Quicksilver," compiled by Metallgesellschaft and Metallurgische Gesellschaft, A.-G., Frankfort-on-the-Main, October, 1903.

Placer mines.—The earliest form of gold mining is the working of alluvial mines or "placers," where the gold has been reduced by the operation of the forces of nature to fine dust mixed with gravel. The work left for the miner is to separate by washing the particles of gold from the surrounding mass of sand and gravel. The final product of the mine is gold.

The pioneers of gold mining in the United States had no experience to guide them but that of the Latin-American countries. The results accomplished by the Spaniards were extremely meager. Mr. T. Wain-Morgan Draper, writing in the Engineering and Mining Journal concerning the gold deposits in Ecuador and Colombia, cites the example of one property which was worked extensively with numerous slaves for over one hundred years. A careful examination and measurement of the work accomplished shows that half a dozen 4-inch "giants" would do as much in one year's time. No such results could be accomplished by the Spaniards with their tiny reservoirs, which, when filled with rain water, were turned loose to wash the gravel down a rock sluice.[1] During the canvass of 1903 there was found in Arizona a placer field of 7,000 acres, divided into numerous claims, worked by Mexicans, where not only was all work done by hand, but even the water was packed or hauled from a distance of 6 or 8 miles.

The beginning of gold mining in the United States dates back to the first quarter of the nineteenth century, when some placer mining was done in North Carolina and Georgia. The settlers worked at odd moments singly or in small gangs, giving to mining such time as they could spare from other occupations. The workings were largely executed by slave labor and were confined chiefly to surface mining.

The gold pan, the long tom, the rocker, and the pick and shovel constituted the miner's outfit. These simple methods still survive wherever placers are worked by miners with practically no capital and without hired labor. It may be fairly estimated that most of the placer gold mined in the Western states and Alaska is produced in this time honored fashion. The following extract, descriptive of placer mining as it was conducted in Alaska as late as 1900, is quoted from an official report:[2]

> The mining on the beach is the simplest operation possible, a rocker being all that is required in addition to a shovel and a pick and a good, strong back. The dirt is shoveled up and thrown onto a coarse screen, which removes the larger stones and trash, the latter derived from the driftwood, etc., from the sea. The fine dirt passes over a series of riffles, which are small obstructions, and is finally washed off, leaving the heavy gold. In some cases the tailings pass over a small piece of carpet or burlap, in other cases an amalgamated silver plate is used; but in each case the object is the same, viz, to catch the fine gold. The heavy particles of gold are caught in the riffles, while the fine either amalgamates or is retained by the carpet, while the lighter material or tailings is washed away.

Soon after the discovery of gold in California, however, the inventive genius of the American miner devised a simple but effective way of working placer mines. The first hydraulic apparatus for working placer mines was introduced in the spring of 1852 by a miner, whose name is not remembered, at his claim at Yankee Jim, Placer county, California.

> This machine was very simple. From a small ditch on the hillside a flume was built toward the ravine, where the mine was opened. The flume gained height above the ground as the ravine was approached, until finally a "head," or vertical height, of 40 feet was reached. At this point the water was discharged into a barrel, from the bottom of which depended a hose, about 6 inches in diameter, made of common cowhide, and ending in a tin tube about 4 feet long, the latter tapering down to a final opening or nozzle of 1 inch. This was the first hydraulic apparatus in California, simple in design, dwarfish in size, yet destined to grow out of its insignificance into a giant powerful enough to move mountains from their foundations. The news spread among the miners, the wonderful practicability of the new invention was at once acknowledged, and, wherever circumstances permitted, a "hydraulic," the name adopted for the novel apparatus, was rigged.[3]

The original idea was much improved upon in the course of time, and the hydraulic method proved a great labor saver, as compared with the primitive pan, rocker, and sluice. The decline of hydraulic mining within the last twenty years is the outcome of a long conflict between the farming and mining interests in California, which has resulted in the débris legislation for the protection of navigable rivers and farming lands. Hydraulic mining requires great space for dumping the masses of earth which are removed from their original position. Formerly, after a bank had been broken up and the gold washed out, the easiest way to get rid of the "tailings" was to discharge them into the nearest stream. With the extension of hydraulic mining the rivers were soon overfilled with débris, which settled in their beds and was deposited all along their course, causing considerable damage to abutting farm lands. An act of Congress was passed in 1893 which requires débris or tailings of all mines operating in the drainage basins of the Sacramento and San Joaquin rivers to be impounded behind dams or other restraining works. This restricts the output, as not nearly as much gravel can be washed in a given time with a given quantity of water as when the débris

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1894, pages 226 to 229.

[2] Ibid., 1900, page 62.

[3] Tenth Census, Vol. XIII, Report on Precious Metals, page 187.

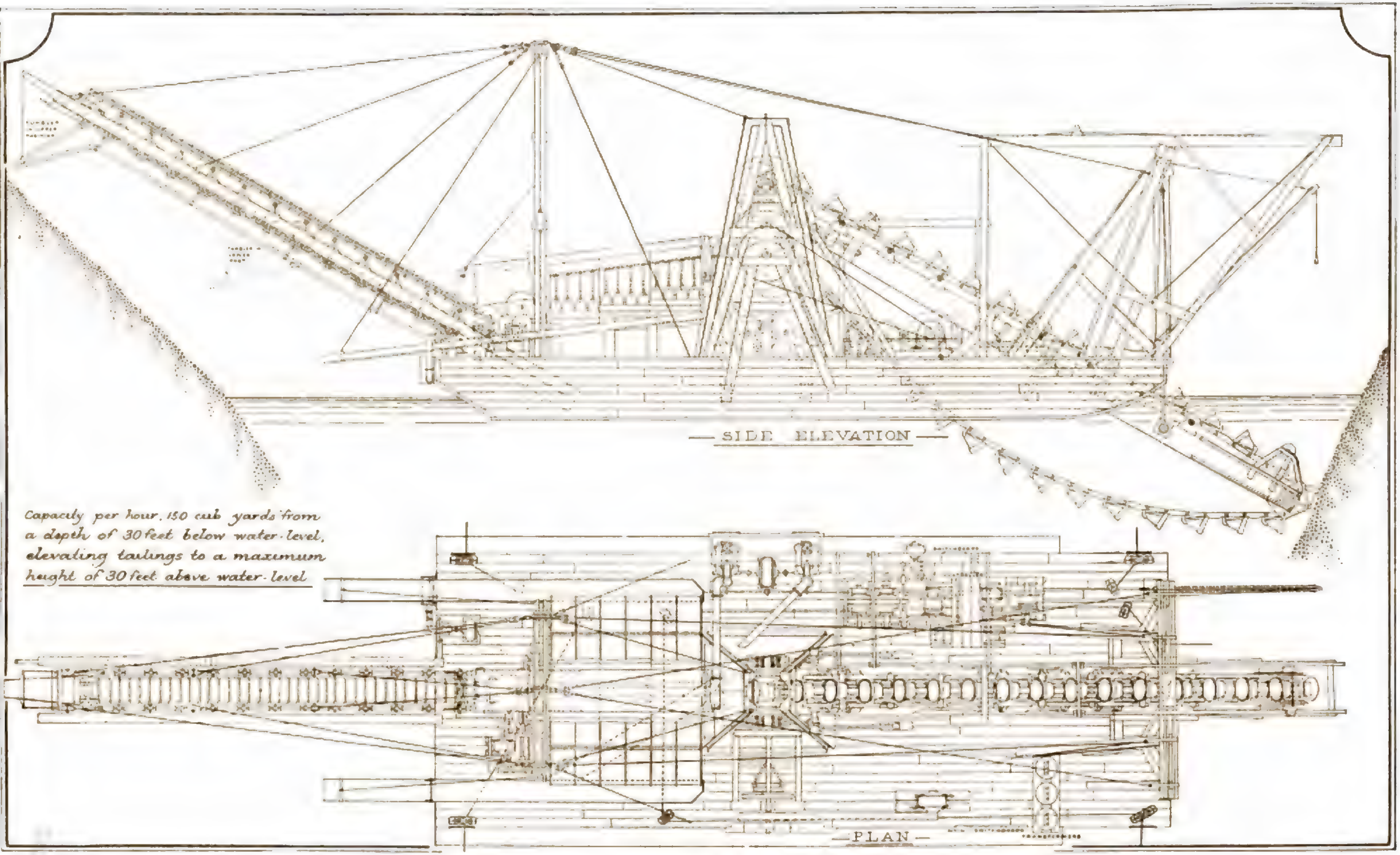
SIDE ELEVATION
Capacity per hour, 150 cub yards from a depth of 30 feet below water-level, elevating tailings to a maximum height of 30 feet above water-level
PLAN

PLATE I.—GOLD DREDGE DRIVEN BY ELECTRIC POWER.

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passed away and took care of itself without having to be impounded.

When the first surface diggings were exhausted, attention was turned to deep lying auriferous gravels which are overlaid by a capping of volcanic rock or by a deep stratum of barren gravel. These mines are worked by drifting.

> The "drifting" process consists in running long tunnels under the lava-capped divides and tapping the ancient river channels, receiving only the lower and richer stratum of gravel and then washing it, or, if cemented, crushing it under light stamps. In some places shafts 70 or 80 feet deep are sunk, and the lower gravel near bed rock is breasted out, hoisted, and washed. The larger drift mines are usually opened by tunnels.[1]

A quarter of a century ago the gravel was shoveled into hand cars and wheeled out to the mouth of the tunnel.[2] Since that time the larger drift mines in following the gravel channel have continued to extend their tunnels until they are miles in length.

> To-day the gravel is removed by trains of cars operated by compressed air or electricity, the power being generated by the water flowing from the tunnels. The tunnels and drifts are lighted by electricity. A material saving in cost is made by the use of these compressed air or electric power plants. The loaded cars run out on the grade, and the power is used for hauling them back to the breasts at or near the foot of the tunnel. The natural drainage of the mines furnishes the power for haulage, lighting, and ventilating.[3]

The latest invention, one which promises to revolutionize the conditions of placer mining, is the dredge. It originated in New Zealand toward the end of the eighties, and after a few years' successful operation in that country was introduced in the United States and is fast gaining ground here. The great advantage of the dredge is that it is not dependent upon a large supply of water, but may be operated miles away from any stream, in the midst of orchard lands. No ditches or reservoirs are necessary, nor need there be a grade or fall for dump. Ground which has lacked suitable fall or water supply may now be mined by means of dredges. The working of these machines is thus described by Mr. Charles G. Yale in a report to the Director of the Mint on gold mining in California:

> A pit or hole is dug at any likely point, in which is built or launched a hull or scow, on which the dredging machinery is placed. The ordinary surface water soon floats the dredge, which then commences operations. The great endless-chain buckets elevate the gravel and earth, which pass through "grizzlies" to separate the rocks and stones and earth. The rocks are carried by elevating apparatus far to the rear of the dredge, while the auriferous material passes through the gold-saving appliances, and the tailings or refuse pass out over the stream. The dredge keeps cutting a new basin for itself to float in as it digs away the bank ahead of it. Of course, the orchard soon disappears under this system, but the underlying gold in the gravel is worth far more than the trees and their product.[4]

The drawing on Plate I shows a California gold dredge which is driven by electric power and raises 150 cubic yards per hour from a depth of 30 feet below water level. The cost of such a machine is from $50,000 to $75,000, which places it beyond the reach of the small placer miner. Large tracts of auriferous ground heretofore lying idle have been bought up to be operated by dredging.[5]

Deep mines (See Plates II and III).—Quartz or deep mining developed naturally from alluvial or placer mining. When the deposits in the beds of the streams or higher up the flanks of the hill were exhausted, the miners followed the lines of the mineral yielding gold and finally came to the mother veins. The beginning of quartz mining also belongs to the Spanish and Portuguese period in the history of this continent. At first the method was merely an adaptation of the processes of alluvial mining. The gold deposit was laid bare by an open cut and worked as nearly as possible like a placer mine. The following description of one of these open mines is quoted from an account of a visit made by Mr. Dawson, secretary of the United States legation at Brazil, to the gold mining region of the state of Minas Geraes:

> In Brazil these (the veins) are often of friable material, which can easily be pulverized with the aid of running water, and the country rock on either side of the vein is also frequently of the same character. Where such veins were found, we encountered the ancient open mines that are so characteristic of Brazilian gold mining. It is evident that the old miners knew nothing of the underground mining, and, except in rare instances, their excavations are open to the top. These great gullies were made with the assistance of running water brought from considerable distances in canals carried along a high level of the mountain flank. The water was conducted to the point where the lower outcrop of the vein began, and as it flowed, with the aid of a pick and shovel, the ore and surrounding material were cut away. This process was continued backward up the hill until the gully became so deep that the débris was unmanageable. The extent of some of these excavations is enormous. One at São João da Chapada, a few miles south of Diamantina, is 150 feet deep, 1,000 feet wide, and 2,000 feet long.
>
> The mass of material washed down was concentrated in the rudest conceivable manner. Even the use of the sluice was not understood, and in its place the gravel was given its first wash in a "canoa." This is merely a level section of the canal in which the gravel and débris is carried down. The water is allowed to fall into this level space over a lip a few inches high, and a workman stirs with a sort of rake the gravel at that point. Below the "canoa" there is an inclined plane covered with hides laid with the hair up in order to catch the gold that does not sink to the bottom. In addition to the loss of gold inevitable with such a system of washing, the miners labored under the disadvantage of being liable to lose their vein by the falling in of the side rock. And not only did they lose the clue, but it is lost forever. Many of these old mines are undoubtedly still rich, but the veins are so covered up by the débris that their outcrops can not be found and traced. An interesting feature of the larger hillside mines are the "mondeas," rectangular masonry reservoirs, 50 to 80 feet square and 10 to 20 feet deep, made to catch and hold material washed down by the canal until it could be conveniently worked. They were necessary where the amount of water was large. In the few instances where the old miners exploited veins for which no

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1901, pages 90, 91.

[2] Tenth Census, Vol. XIII, Report on Precious Metals, page 203.

[3] Report of the Director of the Mint on the Production of the Precious Metals, 1901, page 91.

[4] Ibid., 1899, page 87.

[5] Report of the Director of the Mint on the Production of the Precious Metals, 1901, pages 91 and 92.

water was available, they simply dug a hole, open to the sky, carrying out the mineral and earth upon the heads of slaves.[1]

Another writer says of their methods of quartz mining:

> Quartz mines were only touched where they were found extremely rich, or in a state of decomposition that rendered them easily worked. Explosives were too expensive and difficult to obtain. The mode of working hard quartz was to heat it with fires and then pour cold water upon it, crack it, pry out the pieces, powder it up by hand, and then wash it.[2]

Gold mining in this primitive fashion was possible only with cheap slave labor. "Not the slightest improvement or advance was made as the years went by," says another observer. "The ruins of an abandoned working in Minas Geraes resemble exactly those of the Old World—in Spain, for example, which was to Rome and Carthage what California is to us to-day."[3] The same is true of the silver mines of Peru and Bolivia. "Until a short time ago all ores and all the water had to be carried from the mines on the backs of the workmen in leather bags."[4]

It goes without saying that the absence of mechanical apparatus for hoisting and pumping did not permit of vein mining except at very shallow depths.

In the United States the pioneer state in vein mining was Georgia, where a few deep mines were operated in the first half of the nineteenth century. The first miners naturally followed the methods which were in vogue in the Latin-American countries, whose experience extended over nearly three centuries. It is learned from a recent description that as late as the close of the nineteenth century a specimen of an open mine not very different from its Brazilian prototype was in actual operation in Georgia.

> Where saprolite deposits are being worked by open cut, pipe lines are run from the water supply to the reservoirs or to hydraulic giants in the cuts. While the reservoir is being filled from the pumphouse, men are set to work in the open cut, with picks, to dig out the soft auriferous saprolite, and to break up any large masses of quartz that may be encountered, leaving the material where the waters will have free access to it. One of their number then goes up to the reservoir and opens the gate, when the water pours out in torrents down over the loosened saprolite, mixing with it till it forms a thick, slimy mud of the consistency of fresh mortar. This is gradually thinned down by the rushing waters, and is carried, with the angular blocks of quartz and harder saprolite, through the flume to the mill. The water, heavily charged with solid matter, rushes down the flume, through the sluices, and into the ore bin in the mill, where it deposits the coarser material, such as sand and blocks of saprolite and quartz, while the muddy water, containing a large part of the gold, passes through the racks, out of the mill, and into the nearest stream. The material which has been left in the ore bin is fed, by hand, into the stamp mill, and the gold is caught on the amalgamated copper plates, which vary in length from 4 to 12 feet. Short riffle boxes, containing mercury, are placed in connection with these plates, at their lower end, to catch such of the gold as may pass, with the tailings, over the plates; though it is known to be true that gold coated by limonite ("rusty gold") will not amalgamate, and such of it as is not caught by the riffles must be lost.
>
> One can not repress astonishment that so wasteful a system could have been in use for so long a time, especially as the ores are, for the most part, of low grade, though it is argued in its favor that this method of mining the saprolites carries with it the minimum of expense. While some of the gold, liberated by the disintegration of the auriferous saprolite by the waters, is caught up by the riffles in the sluices, and some finds lodgment in the ore pile in the mill house, still it is said, and is currently believed, that from 25 to 50 per cent of it is lost, being held by the solid matter in the swiftly running waters, eventually passing through the racks of the ore bin and out of the mill house before it is deposited. I am reliably informed that gold passing through the Preacher mill in this way is found all along the bed of the Tanyard branch, from the mill to the creek, a distance of 1 mile.[5]

In the early days of quartz mining in the United States the veins were worked to shallow depths only. In New Mexico about forty years ago powder was practically unknown in mining, and the veins could not be worked for more than 50 feet in depth.[6] Water was another source of trouble. Mines were operated by men of small means, capital was scarce, hand pumps only could be afforded, and when the column of water in the pump became too heavy to be lifted by hand, shafts with a good average grade of ore had to be abandoned. A recent example of this character is cited in the Report of the Geological Survey of Georgia, where but a few years ago a mine was abandoned upon reaching the depth of 300 feet, 30 feet below water level, because the operators had to lift with a hand pump an 80-foot column of water in order to keep the shaft free. At the time work ceased the ore was yielding $25 per ton.[7] The progress in the course of the last half century consisted in the introduction of more powerful hoisting and pumping machinery, in the invention of power drills and more effective explosives, in the construction of extensive tunnels for draining the mines, and lately in the application of electric power.

The evolution of mining methods and machinery is best exemplified by the history of the famous Comstock lode in Nevada. The greatest depth reached after more than twenty years of operation was 3,300 feet. In 1886 work in the lower levels had to be abandoned because of the overpowering flow of water. An instructive description of the powerful pumping plants which were in use at that time is given by Mr. R. K. Colcord, assayer of the United States Mint at Carson City, Nevada:[8]

> The pump of the Union shaft works at the north end of the lode. Still there was what is generally known as a direct-acting double line of Cornish pumps with 10-foot stroke, driven by a compound

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1898, page 180.

[2] Ibid., 1894, page 211.

[3] Ibid., 1901, pages 253, 254.

[4] Ibid., 1894, page 52.

[5] A Preliminary Report on a Part of the Gold Deposits in Georgia, by W. S. Yeates, state geologist, pages 315 to 317.

[6] Report of the Director of the Mint on the Production of the Precious Metals, 1885, page 168.

[7] Geological Survey of Georgia, page 353.

[8] Report of the Director of the Mint on the Production of the Precious Metals, 1901, pages 162 to 166.

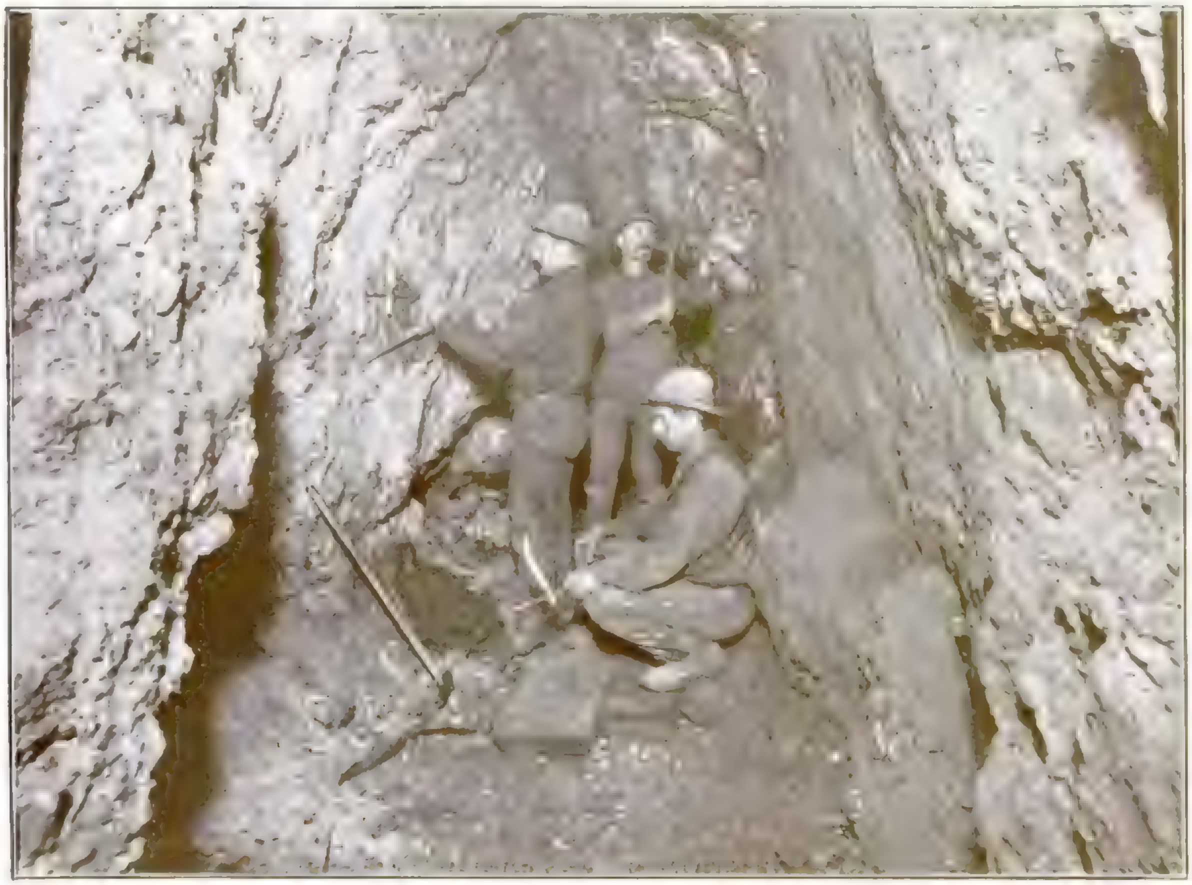

PLATE II.—VEIN IN 1,200-FOOT LEVEL, DALY-JUDGE MINE, PARK CITY, UTAH.

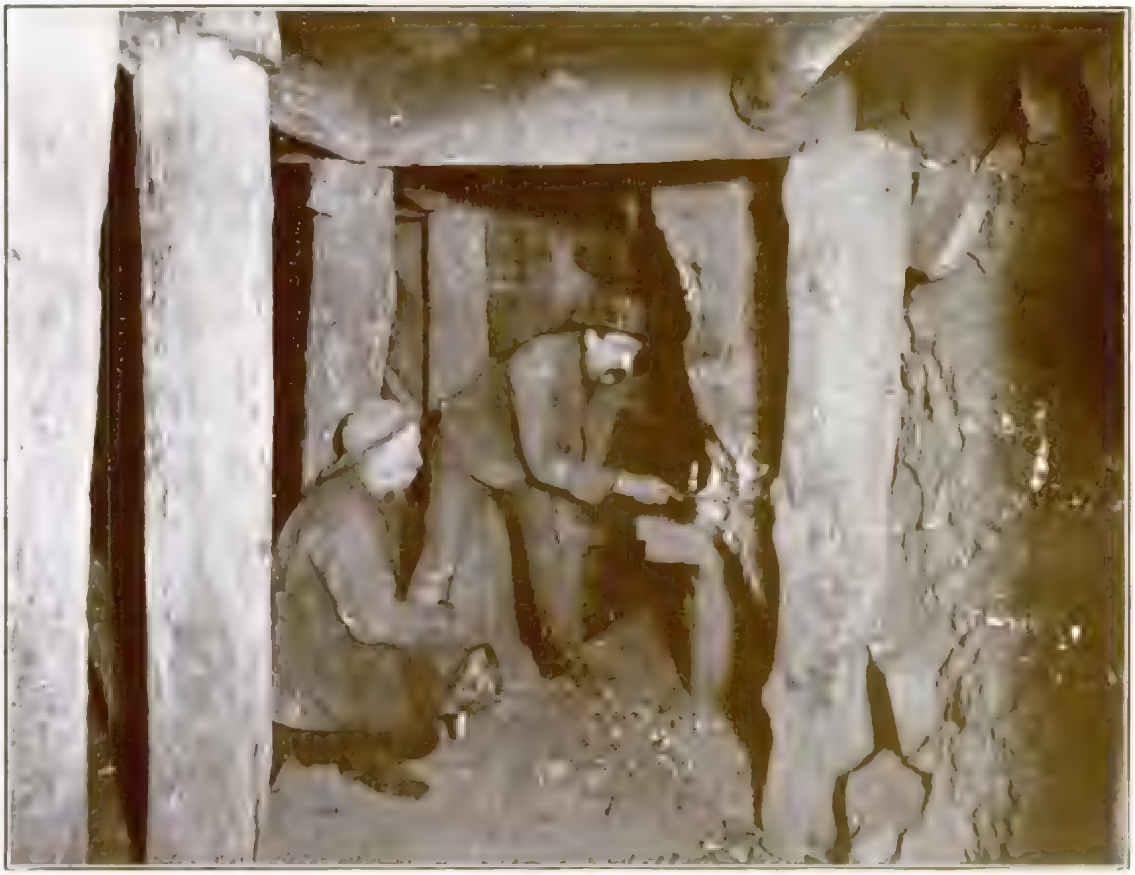

PLATE III.—STOPE, WEST DRIFT, 2,000 FEET FROM LINE, ANCHOR MINE NEAR PARK CITY, UTAH.

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engine within inclined cylinders and inverted walking beam. The initial cylinder is 64 inches in diameter, with 6 foot 9 inch stroke, and the low-pressure cylinder is 100 inches in diameter, with 8 foot 6 inch stroke. The fly wheel is 36 feet in diameter and weighs 208,700 pounds. The wrought-iron walking beam is 22 feet long and weighs 238,610 pounds.

The pump rod is 18 by 18 inch Oregon pine, 2,618 feet in length, and its total weight in motion was 1,620,500 pounds; capacity about 750 gallons per minute to a height of 1,180 feet. This pump was started in 1880 and did good work, but was very expensive in its operation. The whole plant complete cost over $1,000,000.

The Yellow Jacket mine, Gold Hill, had a double line of 14-inch pumps with 10-foot stroke, driven by a horizontal compound engine with double box castings, 64 feet long for the bedplate. The initial cylinder was 31 inches in diameter, with 12-foot stroke, and the low pressure 62 inches in diameter, with 12-foot stroke. The pump rod was 3,055 feet long and weighs, when in motion, 1,510,400 pounds. Its greatest capacity was raising 750 gallons of water 1,516 feet per minute.

The pumps of the combination shaft of the Chollar-Norcross-Savage mining companies, 3,200 feet deep, consisted of a 14-inch Cornish pump and a hydraulic pumping plant, the first on the Comstock. This was operated by waterpower furnished by the Virginia and Gold Hill Water Company and discharged into the Sutro Tunnel. About the time deepest mining was discontinued and the mines allowed to fill and become permanently submerged, which was in October, 1886, this hydraulic system was lifting 2,138 gallons per minute a distance of 1,620 feet to the tunnel level. The total cost of this pumping arrangement was over $1,000,000.

At the date mentioned that hydraulic pump had all the water it could possibly handle. The Hale and Norcross 3,200-foot level had come to a connection with the combination shaft, also the Savage and the Chollar, was drifting south from the shaft on the same level. But the Chollar, drifting toward the already submerged mines of Gold Hill, encountered a constant increase of water—more than the hydraulic pump could manage. The water gained upon the shaftmen, and the result was that as no increase of pump power was feasible all had to submit to the inevitable and allow the hot water to have full submerging sway henceforth.

Recent improvements in electrical engineering and reduction processes have led to the resumption of mining on the levels which had been submerged for many years. Says Mr. Colcord:

> The ponderous and powerful hoisting and pumping steam machinery plants of the chief mining companies, originally costing $500,000, $750,000, or more apiece, have become dismantled, and electric, up-to-date machinery of greater power and efficiency is being substituted and installed in their place at comparatively a mere trifle of their original cost. For instance, the electric-hoist plant of the Union Consolidated mine cost only about $10,000; Yellow Jacket and Belcher, $12,000 each; and that at the C and C shaft of the Consolidated California and Virginia, the most productive mine of the lode, $16,000. The cost of power furnished, as per contract with the Truckee River General Electric Company, is $7 per horsepower, based upon a continuous service and a two-minute peak load. In cases of such continuous service this shows an actual saving of 66 per cent. That is, the former rate for steam power was never less than $21 per horsepower.

Technical progress has been facilitated by modern methods of business organization. The pumping association formed for the purpose of pumping the water from the mines of the Leadville basin may be cited by way of illustration.

> This association includes nearly all the leasing companies, as well as the owners of territory embraced in the Leadville basin. All mines operating within the association territory bear the cost of pumping in proportion to their output, based on net smelter returns less cost of hauling. By means of counters on these pumps the amount pumped is computed in gallons and charged to the association at the rate of 10 cents per 1,000 gallons. Those mines which pump are credited with the amount of water they have raised. Taking the entire district, investigation shows that the flow of water which must be handled is not less than 15,000,000 gallons a day. Comparing this amount of water with the average daily tonnage of the district for the past year, we find that 28.6 tons of water are raised for every ton of ore raised. Careful estimates of the cost of pumping have been compiled and show that it costs 4 cents to pump each ton of water to the surface. Hence, the cost of pumping referred to the ore makes a charge of $1.14 per ton extracted.[1]

Reduction of ores.—The extraction of the metals from the ore was in the early period not differentiated from mining. The most natural method which suggested itself to the human mind for dealing with the gold bearing rock was to reduce it to the same state in which the alluvial gold deposits were found and to separate the disseminated particles of gold from the pulverized mass by the familiar method of washing. These primitive methods are still practiced in the uplands of Mexico. Mr. Robert Hill, an American engineer, who examined some of the auriferous deposits in the state of Sonora, thus relates his observations in a village some 60 miles distant from a railroad station:

> From the adjacent hills the quartz ore was brought in sacks on burros. This was placed upon a flat stone and pulverized with large round bowlders by small boys, this being apparently the first progenitor of the modern stamp mill. The pulverized material was then placed in a primitive arrastra, ground for thirty days by a perambulating burro, and amalgamated. This industry, so the urbane proprietor informed me, had been carried on by himself and ancestors for many generations, and from the ruins of the arrastras in the neighborhood and local tradition there is little doubt that gold has been mined here in a primitive fashion since the first invasion of Sonora by the Spaniards, in 1530, and probably prior to that time by the people who previously inhabited it. From this place onward we found the country inhabited entirely by the peasant class, whose only means of livelihood was to proceed to the hills when in need and procure a little gold with which to purchase the commodities of life.[2]

Amalgamation was the most important discovery inherited by the American miner from his predecessors. Survivals of the most primitive methods of reduction were recorded by the present census of mines and quarries. In a few cases the ore was crushed in ordinary mortars. At one mine in Maryland the ore, after being crushed in a mortar, was smelted in the neighboring blacksmith shop.

A type of mill generally used in the West in the early days of quartz mining was the Mexican arrastra. As late as 1880 arrastras still outnumbered the stamp mills.[3]

> The arrastra in its simplest form consists of a circular bed of rock from 6 to 10 feet in diameter, with walls of vertical planks, having

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[1] Report of the Director of the Mint on the Production of the Precious Metals, 1900, page 118.

[2] The Engineering and Mining Journal, June 25, 1902.

[3] Tenth Census, Vol. XIII, Report on Precious Metals, pages 282, 283.

> an upright pivoted post in the center, from which extend 2 or 4 horizontal arms. Stone drags, weighing usually from 200 to 1,000 pounds each, are attached by ropes or chains to the extremities of the arms, and are slowly drawn around by the rotation of the latter. The depth is usually between 18 and 30 inches. The pavement and drags are of the hardest rock conveniently obtainable. * * * One man per shift can take care of two arrastras. Some waterpower arrastras working on tailings are so arranged that the only attendance needed is in feeding and discharging them, so that practically the labor required is less than the constant work of one man. Continuous arrastras receive no attention other than that demanded for repairs. The smaller arrastras are worked by a single mule or horse. When waterpower is obtainable, a small overshot hurdy-gurdy, or turbine wheel, is employed.[1]

The capacity of an arrastra does not exceed 4 tons per day of twenty-four hours, and usually varies from 1 to 2 tons. A crude arrastra operated by mule power can be built for $150, which places it within the means of miners with but small capital. The owner often does all the work.

Wooden stamp mills of a very crude type were also known to the Spanish-American miners. A quaint specimen of a homemade stamp mill, fairly representative of its Spanish prototype, was seen at work a few years ago in Georgia. The mine and the mill were worked a few months in the year by the owner, with the aid of his aged mother.

> The son packed selected ore in a bag on his back to a rude mill a quarter of a mile from the shafts and emptied it into a nail keg. The mother fed the mill with a shingle. Working thus from sunrise to sunset they eked out a living, never making less than $1 a day apiece. The stamp mill has been accepted by all who have seen it as the first of its kind. A 10-foot overshot water wheel, with axis elongated at one side, set in propped posts, constitutes the motor. Three spindles, roughly hewn, are shod with radially arranged and overlapping bands of iron (pieces of a wheel tire) bound by a ring. These are the stamps. The mortar consists of the remnant of the shoe material. Flat iron plugs, bent at the end, are so arranged in the axis that when it revolves these plugs catch, lift, and drop each notched spindle at different intervals. The screen of the mortar chamber is a piece of iron stovepipe rolled out and punctured with nail holes. A combination sluice box does the rest.[2]

This mill was imitated by other miners in the same and neighboring counties. The cost of construction of a first-class mill of this type did not exceed $100. From the wooden mill, by gradual improvement, the present iron stamp mill, with steel shoes and mortars, was developed. The modern stamp milling process is described as follows:

> Gold stamp milling is that particular process in which a heavy cylindrical body is made to fall upon the ore in such a manner as to crush it, and thereby facilitate a separation between the gold and the valueless minerals by which the gold is incased. The latter weigh less than the former, and are removed by the aid of water. The gold is then collected through the agency of mercury, with which it readily forms an alloy or amalgam. From this combination it is finally extracted by the distillation or retorting of the mercury. The mechanism of the stamp acts on principles similar to those underlying the crudest devices used by man. It may be likened to a hammer, of which the shoe is the hammer head, the stamp stem is the handle, and the die is the anvil. The ore itself has been compared to a nut struck by a hammer, whose blow has separated the valueless shell (the quartz) from the valuable kernel (the gold). Water covers the die and the ore lying upon it. The blow of the falling stamp not only crushes the ore, but also causes a violent pulsation of the water. That pulsation becomes converted into an irregular splash against the sides of the mortar. The latter has an opening in front, through which the water is discharged, carrying with it the crushed ore. This, called the "pulp," spreads itself over tables placed on an incline, which are lined with a metal, usually copper, having an amalgamated surface, such as will arrest the particles of gold and at the same time permit the grains of quartz and other valueless material to pass over it and out of the mill.[3]

With the further progress of gold mining a point was reached where the stamp mill was found inadequate. After the gold bearing veins had been worked to a certain depth, usually a few hundred feet below the surface, the gold would cease to be "free milling" and, because of the lack of those changes which are due to the penetration of water from the surface, would become "refractory," that is, locked up in union with iron pyrite and other materials, so that it would not amalgamate with quicksilver.[4] Many mines were abandoned when the free milling ores gave out. In Gilpin county, Colo., this condition was met with very early in its mining history, at levels varying from 100 to 200 feet.

> The mills which had previously been extracting from 60 per cent to 70 per cent of the gold contents gradually commenced to return only 50 per cent, 40 per cent, and then 30 per cent. None but the richest ore would now pay; the mills swallowed up two-thirds of the yield which should have rewarded the miner's toil; some of the mines were forced to shut down, while others had to confine their development to the narrower, richer portions of the lodes. * * * At this juncture a small smelting establishment was erected in the district, and the metallurgist came to the rescue of the baffled millman.[5]

The problem was not fully solved, however, until the eighties, when the process of concentration was introduced. Only rich ores could bear the expense of shipment to distant smelters. As a result, low-grade refractory ores which could not be treated by amalgamation were thrown away. The new process of concentration, which reduced the volume of ore to be shipped and treated, was tantamount to a discovery of new gold mines.

An illustration of a modern stamp mill, equipped with a concentrator, is shown on Plate IV.

The following description of this process is condensed from the report of the Colorado bureau of mines:

> The system of ore dressing known as concentration is one of the most important of all processes applied to the treatment of ores carrying low values in gold, silver, lead, and copper. There is probably no other line of ore dressing so universally used. Notwithstanding the new devices introduced, all are in line with the early and original designs, differing only in the manner of application of principles involved. The theory of concentration is based

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[1] Tenth Census, Vol. XIII, Report on Precious Metals, pages 282, 283.

[2] A Preliminary Report on a Part of the Gold Deposits of Georgia, pages 68, 69.

[3] Stamp Milling of Gold Ores, by T. A. Rickard, pages 1, 2.

[4] Report of the Director of the Mint, 1901: "The Future of the Gold Supply," by N. S. Shaler, of Harvard University, from the International Monthly, November, 1901.

[5] Stamp Milling of Gold Ores, pages 12 and 14.

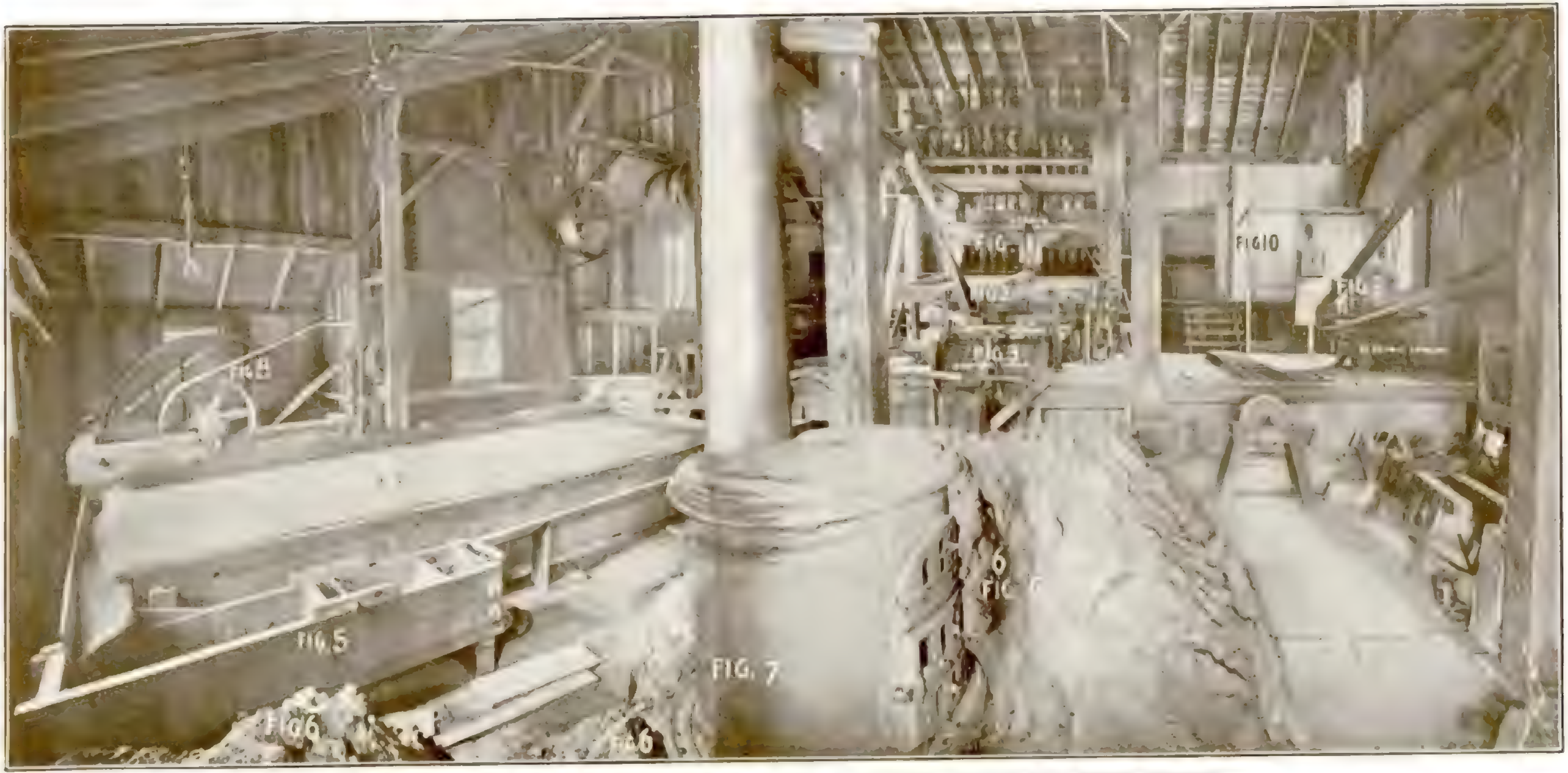

PLATE IV.—INTERIOR OF MILL OF THE UNITED GOLD MINING, MILLING, AND TUNNEL COMPANY, IDAHO SPRINGS, COLORADO.

Fig. 1. Ten-stamp ore crusher. Fig. 2. Amalgamated plates to catch free gold. Fig. 3. Bumping table to catch coarse concentrates. Fig. 4. Wilfley table to catch fine concentrates and slimes. Fig. 5. Concentrating box. Fig. 6. Concentrates piled on the floor. Fig. 7. Heating stove. Fig. 8. Closed-in waterpower wheel (Pelton 4 feet). Fig. 9. Thirty-horsepower electric dynamo, driven by the same waterpower, to operate the machine drills in the mine. Fig. 10. Office and weighing room.

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upon the variable specific gravity of the different minerals. Its application is to separate the various metals, collect those having value, and reject the remainder. A large proportion of the concentrates marketed are derived from the stamp-mill tailings. When the value in tailings is in form of pyrite, chalcopyrite, and galena, with gold and silver associated, the ore passes direct from the plates to different patterns of oscillating, or bumping, tables, and the separation made. Where the base minerals occur in comparatively large crystals the stamp battery is often preceded by crusher, rolls, sizing screens, and hartz jigs, the jigs yielding a coarse concentrate, and the tailings from jigs being recrushed in battery over the plates and tables.[1]

The problem of an economical process for the treatment of low-grade ores for many years tempted the inventive spirit of mining men. Many processes were devised only to be rejected by experience. The "process man" became the object of cheap ridicule even in official publications. It was, however, owing to the efforts of one of the multitude of these "process men" that the cyaniding process was invented, which gave to the world the wealth of South African gold. At first the new process was met with distrust by practical mining men, but its demonstrated success overcame the doubts of the skeptics. Immense dumps of low-grade ore and tailings which had been accumulating since the beginning of mining operations were taken up and reduced by the new process.

It is estimated by Professor Munroe that in 1902 gold to the value of $8,000,000 was produced by the cyaniding process in the United States. This represents an addition of 13 per cent to the productivity of deep gold mines.

Improvement in the processes of extracting the metals from the ore is a potent factor in the development of mining. By the old amalgamation process not more than 70 per cent, and usually not more than 60 per cent, of the gold contents of the ore was saved. With the aid of modern processes more than 90 per cent of the assay contents can be recovered.

General industrial conditions.—The development of the railway system with consequent reduction in freight rates has greatly stimulated the growth of gold and silver mining. When mining operations first commenced in Arizona, some mines were 300 miles away from the nearest railroad, and machinery and supplies were brought in by mule teams.[2] Twenty years ago no mine could be worked there which produced ore worth less than $150 per ton.[3] In some mining districts of Colorado, as late as fifteen years ago, before they were reached by railways, all ores were subject to freight charges, varying from $50 to $100 per ton. These conditions are now largely a thing of the past. To-day, all important mining camps are crossed by spurs and switches connecting the principal mines with the main railway line. This means a saving of many dollars per ton on all ores shipped, besides a saving on coal and other mine supplies. The decrease of the average value of the ore per ton has been noted on a preceding page. In the light of present statistics the following quotation from a report published twenty years ago on silver mining in California is instructive:

> Only ores worth from $100 to $200 are sent to mills. Richer ores are sold in San Francisco or elsewhere, while the low-grade ores are dumped. Dumps are covered with a large quantity of ore, the greater portion of which is low grade, averaging from $40 to $60 to the ton.[4]

Silver ores averaging from $40 to $60 to the ton are to-day considered exceptionally rich.

The decline in the average grade of ore mined and treated must not be mistaken for an indication of what the economists call "diminishing returns." The dumping of a portion of the ore after it has been raised from the mine increases the average cost of mining per ton of ore treated. Since it has become possible to treat low-grade ores which formerly had to be thrown away, the returns have increased in proportion to the expense per ton of ore actually raised, there being no additional cost of mining. Thus production has been cheapened.

The combined effect of all these advances in the processes of mining and reduction and in transportation has been the reopening of many mines which were abandoned years ago when the supply of the very rich choice ores had been exhausted. Says Mr. Yale, who has for many years been a close student of mining conditions in California:

> Along the mother lode the best paying mines of to-day, and the deepest, are those which had lain idle for many years, but were intelligently reopened and properly equipped with modern machinery. Capitalists seem to prefer to reopen a mine which had made a record for bullion output in its early history rather than to take the chances on opening and developing an entirely new prospect. Several of the most productive mines at the present day are those which were abandoned twenty or thirty years ago, at a depth of 400 or 500 feet, when it was thought there was nothing worth seeking for further down. On the reopening of these mines, however, systematic deep sinking was carried on, since which time they have been much more profitable than during their early career.[5]

The introduction of improved machinery and reduction methods calls for a large investment of capital. The effect of the technical progress has therefore been the gradual displacement of the small operator working his mine without hired labor on the "grub-stake" plan, and the concentration of gold and silver mining under the management of large companies. The general trend toward production on a large scale has already been noted. The movement toward combination, however, has as yet not reached the gold and silver mines. Small properties have here and there been combined into larger ones; still these small aggregations in no way differ from ordinary incorporated companies and lack the magnitude which is characteristic of a modern industrial combination. In the reduction of ores, on the other hand, combination has made considerable progress.

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[1] Report of the State Bureau of Mines of Colorado, 1897, pages 134 and 135.

[2] Report of the Director of the Mint on the Production of the Precious Metals, 1901, page 72.

[3] Ibid., 1884, page 56.

[4] Report of the Director of the Mint on the Production of the Precious Metals, 1884, page 542.

[5] Ibid., 1900, pages 82 and 83.

TABLE 90.—DETAILED SUMMARY,

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
1	Number of mines	2,992	4	74	1,020	772	45
2	Number of operators	2,992	4	74	1,020	772	45
	Character of ownership:						
3	Individual	958	2	16	401	166	17
4	Firm	923		15	362	211	11
5	Incorporated company	1,079	2	43	241	389	17
6	Other forms	32			16	6	
	Salaried officials, clerks, etc.:						
7	Total number	3,180	7	166	748	1,148	59
8	Total salaries	$5,076,773	$6,710	$283,033	$1,019,846	$1,687,518	$29,508
	General officers—						
9	Number	137	2	22	69	148	1
10	Salaries	$810,555	$1,000	$50,675	$125,568	$280,002	$905
	Superintendents, managers, foremen, surveyors, etc.—						
11	Number	1,725	4	88	418	551	32
12	Salaries	$2,724,092	$5,150	$157,399	$629,123	$891,257	$19,122
	Foremen below ground—						
13	Number	850	1	35	170	275	19
14	Salaries	$1,090,963	$560	$49,562	$180,383	$345,608	$6,709
	Clerks—						
15	Number	468		21	91	174	7
16	Salaries	$451,163		$25,397	$84,772	$170,651	$2,773
	Wage-earners:						
17	Aggregate average number	36,142	34	1,442	7,989	11,200	334
18	Aggregate wages	$35,077,492	$12,182	$1,498,251	$7,101,003	$11,726,123	$107,718
	Above ground—						
19	Total average number	11,204	12	459	2,675	3,285	187
20	Total wages	$11,233,608	$4,890	$513,076	$2,410,549	$3,556,482	$56,894
	Engineers, firemen, and other mechanics—						
21	Average number	4,515	8	216	986	1,565	47
22	Wages	$5,212,222	$3,990	$285,040	$1,018,277	$1,884,112	$17,102
	Miners—						
23	Average number	1,324		23	521	100	107
24	Wages	$1,013,337		$22,910	$395,939	$92,081	$30,580
	Boys under 16 years—						
25	Average number	21			4	1	3
26	Wages	$6,009			$1,074	$580	$390
	All other wage-earners—						
27	Average number	5,344	4	220	1,164	1,619	30
28	Wages	$5,002,040	$900	$205,126	$995,259	$1,579,709	$8,822
	Below ground—						
29	Total average number	24,938	22	983	5,314	7,915	147
30	Total wages	$23,843,884	$7,292	$985,175	$4,690,454	$8,169,641	$50,824
	Miners—						
31	Average number	18,413	8	636	3,796	6,175	88
32	Wages	$18,737,954	$3,540	$685,314	$3,495,259	$6,340,911	$35,454
	Miners' helpers—						
33	Average number	3,293	7	107	1,013	727	42
34	Wages	$3,004,334	$1,512	$111,936	$799,116	$774,371	$11,236
	Boys under 16 years—						
35	Average number	6			3		
36	Wages	$2,517			$1,040		
	All other wage-earners—						
37	Average number	3,226	7	240	502	1,013	17
38	Wages	$2,099,079	$2,240	$187,925	$386,039	$1,054,359	$4,134
	Average number of wage earners at specified daily rates of pay:						
	Engineers—						
39	$0.75 to $0.99	1					
40	$1.00 to $1.24	26					18
41	$1.25 to $1.49	6					3
42	$1.50 to $1.74	6			2		1
43	$1.75 to $1.99	2	2				
44	$2.00 to $2.24	5			3		
45	$2.50 to $2.74	31			21	2	1
46	$2.75 to $2.99	19		1	11	4	
47	$3.00 to $3.24	354		2	165	126	
48	$3.25 to $3.49	71		2	27	52	
49	$3.50 to $3.74	397		14	57	66	
50	$3.75 to $3.99	37		1	2	14	
51	$4.00 to $4.24	548		52	16	225	
52	$4.25 and over	79		2	7	36	
	Firemen—						
53	$0.75 to $0.99	1					2
54	$1.00 to $1.24	10	2				2
55	$1.50 to $1.74	5					
56	$1.75 to $1.99	1			2		
57	$2.00 to $2.24	15			4	6	
58	$2.25 to $2.49	9			1	6	
59	$2.50 to $2.74	72		6	32	13	
60	$2.75 to $2.99	27		2	5	13	
61	$3.00 to $3.24	144		3	7	48	
62	$3.25 to $3.49	5				1	
63	$3.50 to $3.74	128		11	6	63	
64	$3.75 to $3.99	3					
65	$4.00 to $4.24	34		1	2	17	
66	$4.25 and over	5					
	Machinists, blacksmiths, carpenters, and other mechanics—						
67	$0.75 to $0.79	12					4
68	$1.00 to $1.24	12					4
69	$1.25 to $1.49	11				4	5
70	$1.50 to $1.74	7			1		1
71	$1.75 to $1.99	11	4				2
72	$2.00 to $2.24	68			23	40	4
73	$2.25 to $2.49	20			17		
74	$2.50 to $2.74	135		1	91	19	
75	$2.75 to $2.99	74		4	31	20	
76	$3.00 to $3.24	471		10	191	193	
77	$3.25 to $3.49	109		7	42	40	
78	$3.50 to $3.74	564		28	141	164	
79	$3.75 to $3.99	60		1	10	12	
80	$4.00 to $4.24	737		32	58	347	
81	$4.25 and over	228		16	18	64	

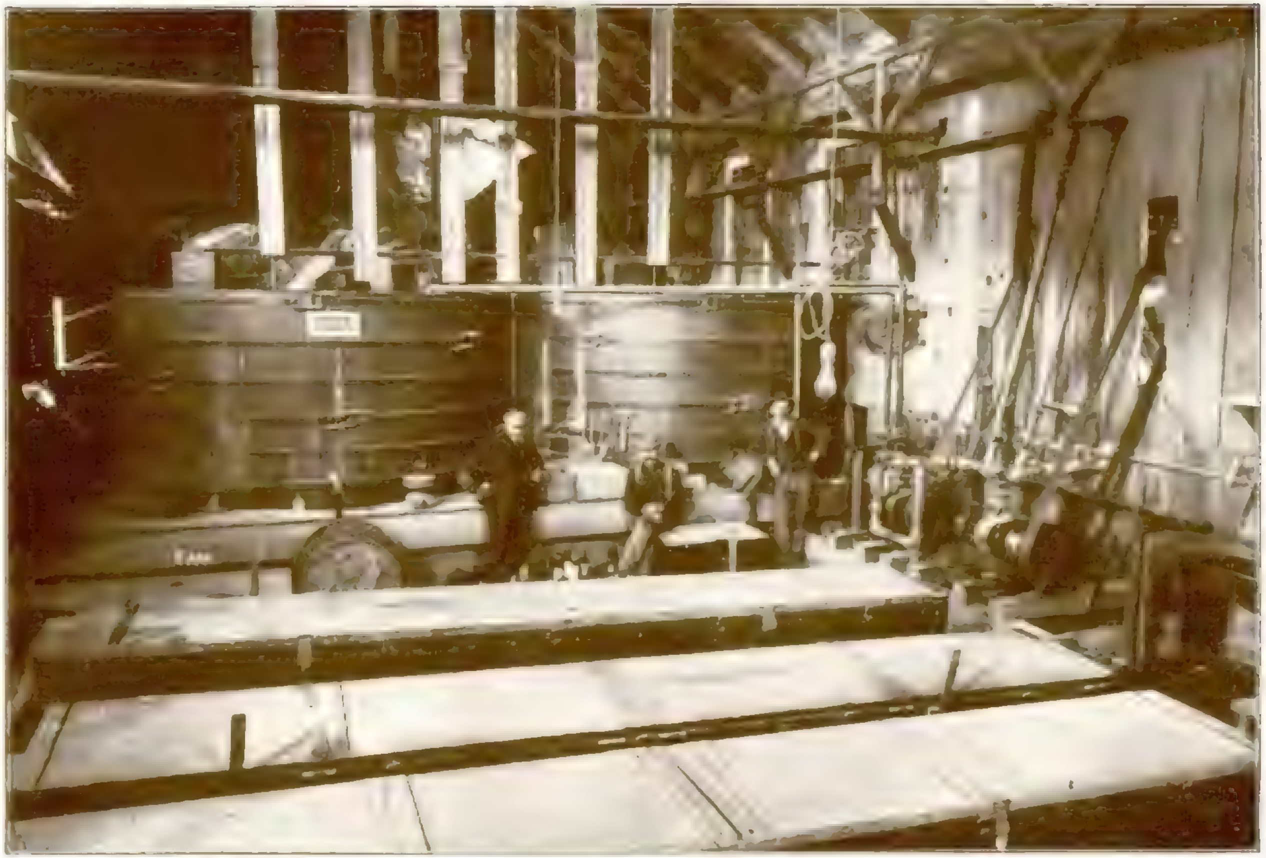

PLATE I.—EUREKA CYANIDE PLANT, NEAR CARSON CITY, NEVADA.

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PRODUCING MINES: 1902.

Idaho.	Montana.	Nevada.	New Mexico.	North Carolina.	Oregon.	South Carolina.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.	All other states.[1]	
258	176	104	91	15	262	3	40	83	5	31	4	5	1
258	176	104	91	15	262	3	40	83	5	31	4	5	2
78	61	35	33	6	118		9	7	2	5	1	1	3
103	50	24	15	3	96	1	7	9	3	11		2	4
75	63	44	39	6	48	2	23	67		15	3	2	5
2	2	1	4				1						6
340	188	146	75	21	310	12	148	261	4	31	1	19	7
$520,548	$318,020	$210,898	$80,390	$18,267	$146,473	$16,750	$222,590	$391,317	$1,815	$36,065	$5,245	$23,840	8
50	21	32	2		10	2	8	59		3		5	9
$98,479	$49,131	$78,224	$6,800		$12,862	$5,000	$16,825	$86,234		$1,920		$5,900	10
154	94	62	43	17	67	7	70	93	3	10	1	8	11
$251,265	$166,158	$103,911	$52,368	$16,390	$32,866	$12,500	$103,852	$167,051	$1,425	$11,580	$5,245	$11,700	12
107	45	20	19	1	19	2	55	69	1	19		4	13
$150,155	$69,748	$32,963	$15,750	$585	$26,955	$550	$86,083	$96,428	$390	$18,065		$4,440	14
40	22	22	11	3	14	1	15	40		2		2	15
$44,649	$22,983	$18,710	$5,472	$1,302	$13,820	$500	$15,230	$41,604		$1,500		$1,800	16
3,382	2,278	1,075	519	200	855	131	2,914	3,349	43	290	25	140	17
$3,698,345	$2,688,052	$1,162,387	$409,779	$66,522	$816,711	$45,500	$5,217,156	$3,176,599	$11,564	$232,658	$24,570	$82,462	18
868	837	372	241	81	436	50	856	848	17	51	8	21	19
$930,418	$976,006	$408,573	$131,232	$28,314	$387,777	$17,650	$911,724	$821,562	$5,186	$53,484	$7,667	$12,148	20
366	283	129	69	28	108	23	319	312	14	28	5	10	21
$437,270	$474,931	$169,899	$75,586	$13,662	$131,662	$8,450	$403,219	$340,735	$4,378	$29,389	$5,221	$8,360	22
128	117	3	31	31	218		32	1	1	2		2	23
$108,814	$122,857	$2,300	$32,914	$8,462	$164,134		$36,555	$1,080	$188	$1,645		$2,808	24
2		2	2	2	2			3					25
$490		$640	$765	$310	$420			$1,780					26
373	437	238	59	20	108	27	505	532	2	21	3	2	27
$383,984	$478,217	$235,794	$52,758	$6,080	$91,621	$8,950	$471,950	$478,174	$620	$22,450	$2,446	$980	28
2,514	1,441	703	378	122	419	81	2,058	2,501	26	178	17	119	29
$2,767,927	$1,712,047	$763,764	$278,527	$38,598	$428,934	$28,100	$2,805,732	$2,335,050	$6,398	$178,574	$16,903	$70,264	30
1,974	1,187	634	286	58	336	28	980	1,919	17	169	15	89	31
$2,161,799	$1,425,868	$686,071	$228,603	$20,675	$347,345	$10,900	$1,173,847	$1,847,831	$4,623	$171,666	$15,393	$52,824	32
334	82	18	54	47	64	20	442	294	9	9		24	33
$352,441	$87,735	$16,786	$31,517	$12,166	$60,989	$6,000	$462,588	$251,798	$1,775	$6,908		$13,200	34
1			1					1					35
$312			$385					$730					36
205	172	51	28	17	19	33	627	287			2	6	37
$233,345	$198,189	$40,597	$17,632	$5,180	$20,640	$11,200	$669,297	$252,673			$1,510	$4,220	38
									4				39
				4		2			2				40
				2		1							41
				2		1							42
													43
		1		1									44
					3			3		1			45
		1	1					1					46
6	1	10	11		4		3	25		1			47
3			3		2			13		1	1		48
69	13	10	5		10		56	25		1	1		49
4	1	2	1		2			6		4			50
53	110	13	3		9		47	16		1		3	51
10	8	12	2		1			1					52
						2							53
				3		3							54
3				1								1	55
				2									56
2			1									2	57
		1						1					58
					1		3	17					59
					2			5					60
3	5	4	2		2		44	26					61
3								1					62
28	14	2	2		1					1			63
3													64
4	8	2											65
1		2						2					66
						6			2				67
				1		1			3				68
				1					1				69
1						3						1	70
				1					1				71
5		1				3			1			1	72
			1	1				1					73
5						1		17					74
		1			4			11					75
11	6	7	7		11		4	22		2			76
3			1		3			19					77
39	32	17	6		29		53	11		14	1		78
1	3		1				4	25					79
95	40	18	14		18		52	16		3	2	2	80
15	22	25	8		6		53	1					81

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[1] Includes operators distributed as follows: Arkansas, 1; Maryland, 1; Tennessee, 2; Texas, 1.

TABLE 90.—DETAILED SUMMARY,

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
	Average number of wage-earners at specified daily rates of pay—Cont'd.						
	Miners—						
82	$0.50 to $0.74	10					
83	$0.75 to $0.99	113					72
84	$1.00 to $1.24	156	2		7		61
85	$1.25 to $1.49	119					32
86	$1.50 to $1.74	117		1	31	2	2
87	$1.75 to $1.99	176	6	12	102		28
88	$2.00 to $2.24	257		6	76	39	
89	$2.25 to $2.49	278		6	67	31	
90	$2.50 to $2.74	2,869		6	1,330	800	
91	$2.75 to $2.99	2,238		34	923	635	
92	$3.00 to $3.24	7,200		271	1,647	3,481	
93	$3.25 to $3.49	715		76	59	49	
94	$3.50 to $3.74	4,310		242	87	547	
95	$3.75 to $3.99	199			2	171	
96	$4.00 to $4.24	910		5	84	498	
97	$4.25 and over	50			2	22	
	Miners' helpers—						
98	$0.50 to $0.74	16					1
99	$0.75 to $0.99	49	7				20
100	$1.00 to $1.24	60					21
101	$1.25 to $1.49	23					
102	$1.50 to $1.74	39		1	2		
103	$1.75 to $1.99	99			95	1	
104	$2.00 to $2.24	136			49	1	
105	$2.25 to $2.49	184		2	155		
106	$2.50 to $2.74	810		12	644	35	
107	$2.75 to $2.99	102		13	30	15	
108	$3.00 to $3.24	1,016		64	21	389	
109	$3.25 to $3.49	248		16	6	223	
110	$3.50 to $3.74	502		9	7	78	
111	$3.75 to $3.99	5				5	
112	$4.00 to $4.24	4			1		
	Timbermen and track layers—						
113	$2.00 to $2.24	1					
114	$2.50 to $2.74	57			21	36	
115	$2.75 to $2.99	23		2	8	2	
116	$3.00 to $3.24	177		1	26	101	
117	$3.25 to $3.49	28		12	9	4	
118	$3.50 to $3.74	207		6	2	119	
119	$3.75 to $3.99	9				9	
120	$4.00 to $4.24	31		1		21	
121	$4.25 and over	3				3	
	Boys under 16 years—						
122	Less than $0.50	4			1		1
123	$0.50 to $0.74	6			3		1
124	$0.75 to $0.99	4					1
125	$1.00 to $1.24	1					
126	$1.25 to $1.49	5				1	
127	$1.50 to $1.74	2			1		
128	$2.00 to $2.24	5			2		
	All other wage-earners—						
129	$0.50 to $0.74	22					18
130	$0.75 to $0.99	48	4			1	9
131	$1.00 to $1.24	104	7		6	2	19
132	$1.25 to $1.49	51		1	27		
133	$1.50 to $1.74	107		8	58	3	
134	$1.75 to $1.99	288		30	20	157	1
135	$2.00 to $2.24	693		119	194	219	
136	$2.25 to $2.49	292		20	177	21	
137	$2.50 to $2.74	1,583		70	611	290	
138	$2.75 to $2.99	101		31	95	69	
139	$3.00 to $3.24	2,804		74	248	1,006	
140	$3.25 to $3.49	405		19	38	201	
141	$3.50 to $3.74	825		23	88	251	
142	$3.75 to $3.99	32			16	14	
143	$4.00 to $4.24	290		11	20	159	
144	$4.25 and over	119		1	7	27	
	Average number of wage-earners employed during each month						
	Men 16 years and over—						
145	January	34,678	32	1,362	7,589	11,163	338
146	February	34,925	34	1,368	7,768	11,197	360
147	March	34,810	34	1,374	8,019	10,844	331
148	April	35,855	34	1,407	8,532	10,959	329
149	May	37,164	32	1,530	8,787	11,391	339
150	June	37,904	31	1,507	8,176	11,678	302
151	July	37,104	34	1,415	7,918	11,573	325
152	August	37,140	36	1,450	7,903	11,425	353
153	September	36,733	37	1,425	7,707	11,312	363
154	October	35,756	38	1,442	8,000	11,370	285
155	November	36,126	32	1,493	8,002	11,086	345
156	December	34,690	31	1,571	7,737	10,384	302
	Boys under 16 years—						
157	January	27			7	1	3
158	February	27			7	1	3
159	March	27			7	1	3
160	April	31			9	1	7
161	May	28			9	1	2
162	June	24			7	1	2
163	July	26			7	1	4
164	August	26			7	1	4
165	September	24			7	1	2
166	October	29			7	1	3
167	November	28			5	1	2
168	December	27			5	1	1
	Contract work:						
169	Amount paid	$626,050	$1,200	$57,600	$47,066	$300,707	$1,030
170	Number of employees	980	2	48	145	173	4

PRODUCING MINES: 1902—Continued.

Idaho.	Montana.	Nevada.	New Mexico.	North Carolina.	Oregon.	South Carolina.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.	All other states.	
......	......	......	......	10	......	......	......	......	......	......	......	......	82
......	......	......	......	35	......	......	......	......	6	......	......	......	83
12	......	......	24	17	......	8	......	......	12	......	......	13	84
......	......	......	1	10	......	20	......	......	......	......	......	56	85
1	......	43	17	11	8	......	......	......	......	......	......	1	86
8	......	......	4	6	10	......	......	......	......	......	......	......	87
6	......	......	53	......	70	......	1	4	......	2	......	......	88
5	......	......	11	......	11	......	......	147	......	......	......	......	89
14	......	12	65	......	108	......	39	485	......	2	......	8	90
20	......	66	23	......	47	......	......	590	......	......	......	......	91
139	75	217	120	......	207	......	32	593	......	87	11	20	92
490	......	6		......	21	......	......	42	......	2	......	......	93
1,083	1,172	46	6	......	66	......	837	49	......	71	4	......	94
3	22	......	......	......	......	......	......	1	......	......	......	......	95
17	28	243	2	......	6	......	12	8	......	7	......	......	96
4	7	4	......	......	......	......	......	1	......	......	......	......	97
......	......	......	......	10	......	......	......	......	5	......	......	......	98
......	......	......	......	18	......	......	......	......	4	......	......	......	99
......	......	......	......	19	......	20	......	......	......	......	......	......	100
......	......	......	2	......	......	......	......	......	......	......	......	21	101
......	......	......	33	......	......	......	......	......	......	......	......	3	102
......	......	......	......	......	......	......	......	3	......	......	......	......	103
4	......	4	5	......	2	......	......	71	......	......	......	......	104
......	......	......	......	......	16	......	......	11	......	......	......	......	105
4	......	......	12	......	3	......	......	91	......	9	......	......	106
......	......	......	......	......	13	......	......	31	......	......	......	......	107
304	62	11	2	......	80	......	53	87	......	......	......	......	108
3	......	......	......	......	......	......	......	......	......	......	......	......	109
19	20	......	......	......	......	......	399	......	......	......	......	......	110
......	......	......	......	......	......	......	......	......	......	......	......	......	111
......	......	8	......	......	......	......	......	......	......	......	......	......	112
......	......	......	......	......	......	......	......	1	......	......	......	......	113
3	......	......	......	......	......	......	......	7	......	......	......	......	114
......	......	......	......	......	......	......	......	11	......	......	......	......	115
27	5	......	......	......	......	......	11	1	......	......	......	5	116
2	......	......	......	......	......	......	......	1	......	......	......	......	117
54	12	......	1	......	3	......	4	6	......	......	......	......	118
......	......	......	......	......	......	......	......	......	......	......	......	......	119
8	1	......	......	......	......	......	......	......	......	......	......	......	120
......	......	......	......	......	......	......	......	......	......	......	......	......	121
1	......	......	......	......	......	......	......	1	......	......	......	......	122
......	......	......	......	2	......	......	......	......	......	......	......	......	123
1	......	1	......	......	1	......	......	......	......	......	......	......	124
1	......	......	......	......	......	......	......	......	......	......	......	......	125
......	......	......	3	......	1	......	......	......	......	......	......	......	126
......	......	1	......	......	......	......	......	......	......	......	......	......	127
......	......	......	......	......	......	......	......	3	......	......	......	......	128
......	......	......	......	4	......	......	......	......	......	......	......	......	129
2	......	......	......	11	......	20	......	......	1	......	......	......	130
9	1	......	1	19	......	33	......	5	1	......	......	1	131
10	......	......	2	......	2	7	......	2	......	......	......	......	132
2	......	20	2	......	4	......	9	......	......	1	......	......	133
2	......	13	2	......	......	......	......	2	......	......	......	1	134
6	2	3	24	3	47	......	16	59	......	1	......	......	135
8	......	......	......	......	3	......	1	67	......	......	......	......	136
18	18	9	15	......	21	......	175	371	......	1	3	1	137
24	......	7	......	......	25	......	3	146	......	1	......	......	138
126	259	179	11	......	1	......	793	109	......	3	......	......	139
98	22	6	......	......	10	......	5	20	......	......	......	......	140
132	218	16	6	......	5	......	80	11	......	13	2	......	141
......	1	......	......	......	......	......	1	......	......	......	......	......	142
53	47	15	1	......	3	......	3	......	......	1	......	......	143
4	23	21	2	......	3	......	31	......	......	......	......	......	144
3,072	2,044	900	480	129	742	131	2,748	3,517	24	188	22	162	145
3,113	2,023	892	501	132	751	131	2,757	3,174	33	236	3	155	146
3,259	2,057	941	483	138	819	131	2,762	3,295	40	216	19	148	147
3,424	2,194	1,061	445	198	894	131	2,868	3,177	42	254	19	147	148
3,516	2,337	1,166	567	212	918	131	2,908	3,255	56	242	19	155	149
3,501	2,456	1,183	512	228	963	131	2,927	3,222	49	207	25	148	150
3,581	2,545	1,180	549	224	955	131	2,930	3,313	47	229	24	131	151
3,543	2,510	1,160	579	231	915	131	2,955	3,419	53	219	34	138	152
3,530	2,417	1,158	544	240	882	131	2,988	3,477	44	236	33	139	153
3,471	2,354	1,113	572	237	825	131	3,007	3,598	38	247	33	132	154
3,447	2,252	1,104	481	232	821	131	3,038	3,502	43	264	33	120	155
3,128	2,147	1,008	479	211	750	131	3,030	3,261	47	230	36	107	156
1	......	3	3	2	3	......	......	4	......	......	......	......	157
1	......	3	3	2	3	......	......	4	......	......	......	......	158
1	......	3	3	2	3	......	......	4	......	......	......	......	159
1	......	3	3	2	1	......	......	4	......	......	......	......	160
4	......	1	3	2	2	......	......	4	......	......	......	......	161
4	......	1	3	2	......	......	......	4	......	......	......	......	162
4	......	1	3	2	......	......	......	4	......	......	......	......	163
4	......	1	3	2	......	......	......	4	......	......	......	......	164
4	......	1	3	2	......	......	......	4	......	......	......	......	165
4	......	1	3	2	4	......	......	4	......	......	......	......	166
4	......	3	3	2	4	......	......	4	......	......	......	......	167
4	......	3	3	2	4	......	......	4	......	......	......	......	168
$41,642	$19,161	$7,944	$52,545	......	$19,197	......	......	$28,493	......	$29,400	$300	......	169
28	20	13	61	......	55	......	......	77	......	27	1	......	170

TABLE 90.—DETAILED SUMMARY.

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
	Miscellaneous expenses:						
171	Total	$5,357,520	$821	$114,046	$967,755	$2,156,217	$9,684
172	Royalties and rent of mine and mining plant	$1,423,390		$2,888	$403,990	$715,309	$3,486
173	Rent of offices, taxes, insurance, interest, and other sundries	$3,934,130	$821	$111,158	$563,765	$1,440,908	$6,198
174	Cost of supplies and materials	$16,699,768	$5,216	$873,091	$2,966,102	$5,605,152	$33,123
175	Value of product	$92,102,052	$1,057	$2,764,677	$15,473,091	$29,655,974	$149,150
	Power:						
176	Total horsepower	196,806	160	5,416	49,692	67,252	3,462
	Owned—						
	Engines—						
	Steam—						
177	Number	1,925	1	100	368	678	32
178	Horsepower	122,354	160	5,086	16,858	48,888	1,403
	Gas or gasoline—						
179	Number	198		16	62	46	
180	Horsepower	4,060		166	957	629	
	Water wheels—						
181	Number	788		1	518	76	14
182	Horsepower	43,936		9	21,517	7,392	2,059
	Other power—						
183	Number	156		2	20	92	
184	Horsepower	8,003		155	1,378	3,447	
	Rented—						
185	Electric, horsepower	14,469			6,990	6,707	
186	Other power, horsepower	2,983			1,992	189	
	Electric motors owned—						
187	Number	750	1	8	265	285	1
188	Horsepower	32,003	12	107	12,081	10,305	100
189	Supplied to other establishments, horsepower	323			100	223	

PRODUCING MINES: 1902—Continued.

Idaho.	Montana	Nevada	New Mexico.	North Carolina	Oregon.	South Carolina.	South Dakota	Utah.	Virginia.	Washington	Wyoming.	All other states	
$614,670	$310,145	$172,206	$34,110	$10,238	$114,402	$4,440	$240,112	$570,250	$444	$23,651	$160	$14,175	171
$28,047	$102,168	$49,652	$13,127	$415	$58,252	$70	$6,406	$25,245	$370	$14,876	......	$1,060	172
$586,623	$207,977	$122,554	$20,983	$9,823	$56,110	$4,370	$233,706	$547,106	$74	$8,775	$160	$13,115	173
$1,695,686	$1,069,300	$599,928	$256,816	$26,490	$290,705	$20,860	$1,966,617	$1,312,176	$4,011	$55,668	$11,139	$20,378	174
$8,177,267	$4,688,536	$3,409,348	$677,168	$71,287	$1,851,858	$138,863	$6,464,258	$8,500,904	$2,723	$339,351	$4,923	$112,622	175
12,115	12,305	4,429	4,000	815	2,949	450	13,329	10,227	92	946	360	215	176
144	183	48	66	26	54	9	76	85	4	17	5	5	177
9,533	9,525	2,883	3,161	815	1,713	450	11,896	8,811	92	747	360	165	178
23	4	17	17	......	7	......	1	3	......	2	......	......	179
1,382	29	342	278	......	115	......	8	120	......	34	......	......	180
88	22	20	6	......	30	......	......	11	......	2	......	......	181
7,553	1,602	1,117	500	......	1,091	......	......	1,066	......	40	......	......	182
10	9	1	3	......	1	......	10	15	......	2	......	1	183
472	402	40	61	......	30	......	1,425	418	......	125	......	50	184
175	150	46	......	......	......	......	......	511	......	......	......	......	185
......	800	1	......	......	......	......	......	1	......	......	......	......	186
39	44	27	13	......	14	1	4	67	......	1	......	......	187
2,112	2,152	1,107	467	......	666	35	70	2,752	......	30	......	......	188
......	......	......	......	......	......	......	......	......	......	......	......	......	189

TABLE 91.—DETAILED SUMMARY, MINES REPORTING

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
1	Number of mines	3,252	3	380	389	955	8
2	Number of operators	3,252	3	380	389	955	8
	Character of ownership:						
3	Individual	683	2	71	111	237	3
4	Firm	849		98	131	282	3
5	Incorporated company	1,695	1	207	146	433	2
6	Other form	25		4	1	3	
	Salaried officials, clerks, etc.:						
7	Total number	2,284	4	385	259	449	6
8	Total salaries	$2,335,470	$3,100	$458,872	$264,575	$434,888	$8,568
	General officers—						
9	Number	302		32	22	64	3
10	Salaries	$242,989		$44,896	$12,995	$42,641	$4,800
	Superintendents, managers, foremen, surveyors, etc.—						
11	Number	1,307	3	253	167	271	2
12	Salaries	$1,523,627	$2,200	$333,944	$188,552	$299,155	$3,600
	Foremen below ground—						
13	Number	430		38	41	77	1
14	Salaries	$410,185		$43,611	$36,698	$71,034	$168
	Clerks—						
15	Number	245	1	62	29	37	
16	Salaries	$158,669	$900	$36,421	$26,330	$22,058	
	Wage-earners:						
17	Aggregate average number	11,763	7	2,243	1,447	2,303	29
18	Aggregate wages	$11,580,684	$2,644	$2,326,885	$1,311,152	$2,314,208	$11,552
	Above ground—						
19	Total average number	2,845	6	604	405	488	9
20	Total wages	$2,782,876	$2,332	$637,741	$359,718	$525,254	$3,563
	Engineers, firemen, and other mechanics—						
21	Average number	1,572	2	308	189	350	3
22	Wages	$1,766,784	$960	$389,446	$190,459	$396,198	$1,200
	Miners—						
23	Average number	312	1	53	75	29	
24	Wages	$235,955	$463	$40,545	$62,341	$25,138	
	Boys under 16 years—						
25	Average number	5		2			
26	Wages	$1,100		$480			
	All other wage-earners—						
27	Average number	956	3	241	141	109	6
28	Wages	$779,037	$909	$207,270	$106,918	$103,918	$2,363
	Below ground—						
29	Total average number	8,918	1	1,639	1,042	1,815	20
30	Total wages	$8,797,808	$312	$1,689,144	$951,434	$1,788,954	$7,989
	Miners—						
31	Average number	8,019		1,506	909	1,662	20
32	Wages	$8,057,301		$1,567,580	$846,810	$1,634,154	$7,989
	Miners' helpers—						
33	Average number	571		67	79	61	
34	Wages	$456,292		$63,475	$59,700	$63,256	
	Boys under 16 years—						
35	Average number	1					
36	Wages	$450					
	All other wage-earners—						
37	Average number	327	1	66	54	92	
38	Wages	$283,765	$312	$58,089	$44,924	$91,544	
	Average number of wage-earners at specified daily rates of pay:						
	Engineers—						
39	$0.75 to $0.99	3					
40	$1.00 to $1.24	4	1				
41	$1.25 to $1.49	9					2
42	$1.50 to $1.74	3			1		
43	$1.75 to $1.99	1					
44	$2.00 to $2.24	3			1		
45	$2.25 to $2.49	2			1		
46	$2.50 to $2.74	20		3	4		
47	$2.75 to $2.99	9		1	6		
48	$3.00 to $3.24	106		4	39	33	
49	$3.25 to $3.49	20		2		11	
50	$3.50 to $3.74	141		15	11	27	
51	$3.75 to $3.99	8				2	
52	$4.00 to $4.24	214		78	1	73	
53	$4.25 and over	58		20	1	8	
	Firemen—						
54	$1.00 to $1.24	9					
55	$1.25 to $1.49	1					
56	$1.75 to $1.99	1					
57	$2.00 to $2.24	4			1		
58	$2.50 to $2.74	5				1	
59	$2.75 to $2.99	1					
60	$3.00 to $3.24	25			1	5	
61	$3.50 to $3.74	30		2	1	9	
62	$4.00 to $4.24	12		4		1	
	Machinists, blacksmiths, carpenters, and other mechanics—						
63	$0.75 to $0.99	1					
64	$1.00 to $1.24	7				1	
65	$1.25 to $1.49	22					
66	$1.50 to $1.74	9					1
67	$1.75 to $1.99	2					
68	$2.00 to $2.24	12	1	1			
69	$2.25 to $2.49	3		2			
70	$2.50 to $2.74	26			15	2	
71	$2.75 to $2.99	7			3	1	
72	$3.00 to $3.24	211		10	54	81	
73	$3.25 to $3.49	27		2	6	6	
74	$3.50 to $3.74	227		31	26	21	
75	$3.75 to $3.99	13		1	4	3	
76	$4.00 to $4.24	261		100	10	55	
77	$4.25 and over	55		25	2	9	

DEVELOPMENT WORK WITHOUT PRODUCTION: 1902.

Idaho.	Montana.	Nevada.	New Mexico.	North Carolina.	Oregon.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.	All other states.[1]	
325	126	82	156	28	187	111	266	4	143	83	3	1
325	126	82	156	28	187	111	266	4	143	83	3	2
64	30	7	49	11	36	13	28	...	12	5	1	3
100	37	12	25	7	51	21	47	...	25	15	...	4
158	59	61	73	10	100	80	288	4	106	63	2	5
3		2	9	...	...	...	3	...	...	...	...	6
180	73	142	105	41	159	89	210	8	119	75	...	7
$164,560	$80,099	$181,172	$88,921	$92,965	$149,674	$114,956	$160,694	$4,535	$110,217	$78,234	...	8
28	22	23	9	2	7	18	19	1	9	13	...	9
$26,917	$20,000	$24,415	$6,475	$600	$7,710	$18,174	$20,671	$180	$7,400	$19,680	...	10
91	32	58	65	27	89	43	55	5	62	40		11
$80,914	$45,057	$86,607	$65,132	$22,673	$119,003	$64,635	$90,511	$3,035	$62,684	$42,775		12
47	9	37	16	8	25	33	18	2	36	12	...	13
$57,405	$11,407	$49,160	$9,507	$5,116	$25,016	$31,604	$12,556	$700	$33,059	$10,254	...	14
14	6	24	15	4	8	5	18	...	12	10	...	15
$10,258	$3,635	$26,990	$7,807	$8,460	$3,945	$2,153	$8,556		$7,074	$5,525	...	16
852	181	574	356	343	802	522	709	51	495	304	18	17
$897,412	$352,700	$654,169	$269,386	$102,131	$776,607	$581,163	$900,217	$17,964	$607,478	$311,881	$7,195	18
227	71	122	64	131	206	152	145	19	104	102	10	19
$216,635	$83,820	$155,809	$52,621	$58,413	$181,995	$117,506	$151,505	$7,108	$108,022	$106,788	$4,095	20
85	57	82	39	56	78	87	123	7	58	54	4	21
$96,025	$71,022	$115,237	$84,907	$21,387	$88,202	$103,160	$126,909	$2,550	$67,805	$59,117	$2,030	22
68	...	3	4	28	38	3	1	...	9	...	...	23
$52,145	...	$2,923	$2,818	$7,264	$31,168	$3,255	$450	...	$7,448	...	...	24
...	...	1	...	1	...	...	...	1	...	...	...	25
...	...	$908	...	$575	...	...	...	$180	...	...	...	26
74	34	36	21	46	90	42	51	11	37	48	6	27
$68,464	$12,799	$37,311	$14,806	$9,720	$92,625	$41,001	$23,867	$4,138	$32,769	$47,671	$2,065	28
625	410	452	292	212	596	390	791	32	391	202	8	29
$680,777	$468,889	$500,300	$217,375	$63,688	$594,612	$453,657	$751,911	$10,795	$429,456	$205,093	$3,400	30
572	382	420	252	110	503	360	724	31	367	183	8	31
$626,151	$451,582	$467,442	$194,869	$36,989	$515,899	$405,747	$683,351	$10,444	$408,891	$186,193	$3,400	32
37	8	25	33	90	67	21	51	...	16	13	...	33
$37,505	$8,388	$27,073	$18,846	$23,809	$60,612	$19,930	$47,623	...	$13,375	$12,600	...	34
...	...	...	1	...	...	...	...	...	...	...	...	35
...	...	...	$450	...	...	...	...	...	...	...	...	36
16	10	7	6	12	26	9	13	1	8	6	...	37
$17,031	$9,100	$5,785	$3,210	$2,800	$18,101	$7,980	$10,957	$552	$7,190	$6,300	...	38
...	...	...	...	5	...	...	...	...	...	...	...	39
...	...	...	...	3	...	...	...	...	...	...	...	40
...	...	...	...	5	...	...	...	2	...	...	...	41
...	...	...	...	1	...	...	...	1	...	...	...	42
...	...	...	...	1	...	...	...	...	...	...	...	43
...	...	...	1	...	...	...	...	...	...	1	...	44
...	...	...	...	...	1	...	...	...	...	...	...	45
...	...	...	1	...	5	...	...	...	1	3	...	46
...	...	...	...	...	...	...	1	...	1	...	...	47
2	...	1	5	...	...	8	12	...	1	...	1	48
...	...	...	...	...	...	1	5	...	...	1	...	49
9	...	14	6	...	6	21	21	...	10	2	...	50
...	...	...	...	...	...	...	2	...	...	1	...	51
14	17	6	...	...	1	4	7	...	8	2	...	52
4	5	12	...	...	1	2	2	...	1	2	...	53
...	...	...	...	9	...	...	...	...	...	...	...	54
...	...	...	...	...	...	...	...	...	...	...	1	55
...	...	...	2	...	1	...	...	...	...	...	...	56
...	...	...	2	...	1	...	...	...	...	...	...	57
...	...	...	1	...	...	1	1	...	...	...	...	58
...	...	...	...	...	...	...	...	...	...	...	...	59
3	...	4	...	...	...	1	6	...	...	1	...	60
...	4	2	1	...	...	...	4	...	1	2	...	61
...	3	1	...	...	...	...	...	...	1	1	...	62
...	...	...	...	1	...	...	...	...	...	...	...	63
...	...	...	...	5	...	...	...	1	...	...	...	64
1	...	...	...	18	...	...	...	1	...	...	2	65
...	...	...	1	6	...	...	...	1	...	...	...	66
...	...	...	...	2	...	...	...	...	...	...	...	67
...	...	...	2	1	2	...	1	1	...	...	...	68
...	...	...	...	1	...	...	...	...	...	...	...	69
1	...	1	2	...	1	...	...	...	...	...	...	70
...	...	...	...	...	1	...	1	...	1	...	...	71
14	...	6	4	...	10	3	17	...	4	6	...	72
...	...	...	2	...	1	1	5	...	...	...	...	73
17	6	18	8	...	25	46	16	...	11	14	...	74
...	...	...	...	...	2	...	1	...	1	2	...	75
15	17	9	1	...	18	9	11	...	14	8	...	76
5	4	8	1	...	7	...	...	...	1	...	...	77

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[1] Includes operators distributed as follows: Arkansas, 1; Maryland, 1; New Jersey, 1.

TABLE 91.—DETAILED SUMMARY, MINES REPORTING

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
	Average number of wage earners at specified daily rates of pay—Cont'd.						
	Miners—						
78	$0.50 to $0.74	1					1
79	$0.75 to $0.99	59					1
80	$1.00 to $1.24	86	1				8
81	$1.25 to $1.49	64		11	2		10
82	$1.50 to $1.74	132		94	5		
83	$1.75 to $1.99	74		40	9		
84	$2.00 to $2.24	182		77	16	12	
85	$2.25 to $2.49	59			10	13	
86	$2.50 to $2.74	764		69	291	174	
87	$2.75 to $2.99	591		5	248	152	
88	$3.00 to $3.24	2,901		290	411	956	
89	$3.25 to $3.49	236		40	4	46	
90	$3.50 to $3.74	2,611		814	61	205	
91	$3.75 to $3.99	100		13	5	33	
92	$4.00 to $4.24	418		103	12	86	
93	$4.25 and over	23		3		14	
	Miners' helpers—						
94	$0.50 to $0.74	9					
95	$0.75 to $0.99	63					
96	$1.00 to $1.24	18					
97	$1.25 to $1.49	5					
98	$1.50 to $1.74	11		1	1		
99	$1.75 to $1.99	4		1		2	
100	$2.00 to $2.24	44		1	10		
101	$2.25 to $2.49	26			20	2	
102	$2.50 to $2.74	105		4	35	9	
103	$2.75 to $2.99	40		1	6	6	
104	$3.00 to $3.24	172		11	6	23	
105	$3.25 to $3.49	11		10			
106	$3.50 to $3.74	52		5		12	
107	$4.00 to $4.24	7				7	
	Timbermen and track layers—						
108	$1.50 to $1.74	4					
109	$2.00 to $2.24	1				1	
110	$2.25 to $2.49	2				2	
111	$2.50 to $2.74	9			3	2	
112	$2.75 to $2.99	3			1	2	
113	$3.00 to $3.24	14			1	6	
114	$3.25 to $3.49	1					
115	$3.50 to $3.74	8				2	
116	$4.00 to $4.24	1				1	
	Boys under 16 years—						
117	Less than $0.50	1					
118	$0.50 to $0.74	1					
119	$0.75 to $0.99	1		1			
120	$1.00 to $1.24	2		1			
121	$1.50 to $1.74	1					
	All other wage earners—						
122	Less than $0.50	11					
123	$0.50 to $0.74	7			1	1	
124	$0.75 to $0.99	36			1		
125	$1.00 to $1.24	49	4	6	3	5	2
126	$1.25 to $1.49	32		15	1	1	4
127	$1.50 to $1.74	60		30	3	10	
128	$1.75 to $1.99	56		5	2		
129	$2.00 to $2.24	110		4	40	9	
130	$2.25 to $2.49	53		5	24	2	
131	$2.50 to $2.74	184		34	68	16	
132	$2.75 to $2.99	68		21	20	16	
133	$3.00 to $3.24	359		111	18	81	
134	$3.25 to $3.49	13		2	2	3	
135	$3.50 to $3.74	106		25	1	17	
136	$3.75 to $3.99	2			1	1	
137	$4.00 to $4.24	47		11	5	21	
138	$4.25 and over	12		8		2	
	Average number of wage-earners employed during each month.						
	Men 16 years and over—						
139	January	9,857	1	1,878	1,069	1,986	25
140	February	9,937	1	1,934	1,103	2,023	25
141	March	10,165		2,052	1,209	2,010	26
142	April	10,394	8	2,092	1,273	1,977	26
143	May	10,957	8	2,176	1,343	2,073	33
144	June	11,620	8	2,166	1,420	2,276	33
145	July	12,335	8	2,209	1,480	2,453	33
146	August	12,636	10	2,217	1,504	2,560	33
147	September	13,231	10	2,250	1,600	2,684	27
148	October	13,384	10	2,476	1,696	2,623	31
149	November	13,482	10	2,711	1,828	2,508	28
150	December	13,016	10	2,671	1,839	2,369	28
	Boys under 16 years—						
151	January	4		1			
152	February	4		1			
153	March	6		3			
154	April	6		3			
155	May	7		3			
156	June	5		1			
157	July	5		1			
158	August	5		1			
159	September	6		1			
160	October	8		3			
161	November	8		3			
162	December	8		3			
	Contract work:						
163	Amount paid	$1,542,771		$197,321	$74,538	$580,748	
164	Number of employees	5,649		317	119	902	

DEVELOPMENT WORK WITHOUT PRODUCTION: 1902—Continued.

Idaho.	Montana.	Nevada.	New Mexico.	North Carolina.	Oregon.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.	All other states.	
												78
				51				7				79
			4	70			1	2				80
			6	9			2	22			2	81
		1	18	8							6	82
		2	23									83
11			36		18		11		1			84
			8		19		6		3			85
6		18	53		96	2	94		32	19		86
31			6		22	1	126					87
138	5	158	90		250	70	362		59	52		88
27	7	45	2		7	1	33		12	12		89
348	315	90	8		111	270	88		212	87		90
1	19	6				1	1		13	8		91
14	45	103	2		15	18	1		44	5		92
4	1	1										93
				7					2			94
				63								95
			2	16								96
			1	4								97
			12									98
	1											99
1			12		14		2		1	3		100
2					2							101
1		5	4		21	5	18		3			102
8			1		7		11					103
7		20	1		16	13	23		9	10		104
									1			105
18	7				7	3						106
												107
			4									108
												109
												110
							3			1		111
												112
		3	1		1		2					113
									1			114
										1		115
												116
								1				117
				1								118
												119
		1										120
			1									121
		2		9								122
				6								123
				34				1				124
				9	4		4	10			2	125
2			1	1	1		2				4	126
1			4		10	1	1					127
		1	3		40		1		2	2		128
1	1	5	8		7	1	1		2	1		129
4		1			9		5		2	1		130
14	2	1	1		11	17	14	1	4	1		131
3		1					2		5			132
44	18	21	4		30	29	5		27	11		133
1					3		1			1		134
15	3	3				3	3		1	35		135
		5										136
4									1			137
1			1									138
617	347	517	304	327	620	551	833	34	460	292	6	139
626	350	475	298	341	629	543	837	37	468	243	6	140
653	316	472	299	342	691	518	850	35	449	237	6	141
692	303	504	335	343	762	485	797	38	484	249	26	142
736	425	523	322	350	842	412	883	49	491	262	26	143
856	504	542	330	327	925	458	927	54	518	320	26	144
924	506	565	413	348	952	474	918	54	547	370	26	145
1,012	538	641	391	327	902	625	967	64	542	367	27	146
1,071	613	672	460	361	908	557	963	57	528	443	27	147
1,059	638	672	401	341	856	578	1,031	55	495	394	28	148
1,035	635	658	350	338	805	548	1,118	61	516	244	6	149
943	594	635	357	364	734	615	1,108	62	444	237	6	150
		1	1	1								151
		1	1	1								152
		1	1	1								153
		1	1	1								154
		1	1	1				1				155
		1	1	1				1				156
		1	1	1				1				157
		1	1	1				1				158
		1	1	1				2				159
		1	1	1				2				160
		1	1	1				2				161
		1	1	1				2				162
$158,262	$65,797	$27,133	$58,128		$75,594		$159,959		$75,684	$60,604		163
254	810	500	1,919		137		291		198	118		164

TABLE 91.—DETAILED SUMMARY, MINES REPORTING

		United States.	Alabama.	Arizona.	California.	Colorado.	Georgia.
	Miscellaneous expenses:						
165	Total	$1,017,356	$889	$123,841	$125,755	$211,781	$485
166	Royalties and rent of mine and mining plant	$71,131		$1,400	$35,802	$19,284	$100
167	Rent of offices, taxes, insurance, interest, and other sundries	$946,225	$889	$122,441	$89,953	$192,497	$385
168	Cost of supplies and materials	$5,075,077	$1,048	$920,886	$610,492	$1,004,587	$2,287
	Power:						
169	Total horsepower	56,065	157	6,211	6,799	16,862	328
	Owned—						
	Engines—						
	Steam—						
170	Number	965	7	112	114	273	9
171	Horsepower	36,009	153	4,220	3,075	11,367	248
	Gas or gasoline—						
172	Number	219	1	95	20	36	
173	Horsepower	3,477	4	1,750	200	499	
	Water wheels—						
174	Number	136		1	96	28	2
175	Horsepower	11,724		2	2,509	2,625	80
	Other power—						
176	Number	111		9	10	61	
177	Horsepower	3,970		239	212	2,143	
	Rented—						
178	Electric, horsepower	795			597	188	
179	Other power, horsepower	230			156	40	
	Electric motors owned—						
180	Number	66		16	24	24	
181	Horsepower	2,572		177	1,153	898	

DEVELOPMENT WORK WITHOUT PRODUCTION: 1902—Continued.

Idaho.	Montana.	Nevada.	New Mexico.	North Carolina.	Oregon.	South Dakota.	Utah.	Virginia.	Washington.	Wyoming.	All other states.	
$98,217	$85,771	$70,435	$38,975	$9,647	$46,792	$45,210	$133,396	$9,702	$56,788	$34,863	.....	165
$300	$1,751	$5,638	.....	$848	$655	$270	$5,123	.....	.....		.....	166
$97,917	$84,020	$64,797	$38,975	$8,799	$46,137	$44,940	$128,273	$9,702	$56,788	$34,863	.....	167
$405,068	$259,902	$474,077	$122,238	$61,332	$233,936	$166,885	$466,475	$26,905	$229,865	$110,254	$3,780	168
4,493	3,700	1,819	3,547	1,087	1,713	2,064	2,411	90	5,142	1,073	60	169
45	82	25	60	39	35	58	52	5	33	31	5	170
1,494	3,247	1,305	2,935	967	1,013	1,870	2,004	85	846	1,000	60	171
6	1	21	1	.....	11	1	14	1	7	1	.....	172
45	5	129	12	.....	97	74	232	5	59	8	.....	173
24	7	3		1	15	7	2	.....	11	2	.....	174
2,779	300	40	.....	70	584	60	90	.....	2,470	15	.....	175
1	20	2	3	.....	.....	12	.....	.....	2	1	.....	176
175	250	45	110	.....	.....	600	.....	.....	95	50	.....	177
.....	.....	.....	.....	.....	.....	.....	16	.....	.....	.....	.....	178
.....	.....	.....	.....	.....	19	.....	15	.....	.....	.....	.....	179
2	2	11	.....	.....	2	.....	3	.....	2	.....	.....	180
60	75	137			33	.....	25	.....	15	.....	.....	181

PRECIOUS METALS RECOVERED BY CYANIDE PROCESSES

Google

PRECIOUS METALS RECOVERED BY CYANIDE PROCESSES.

By Charles E. Munroe, Ph. D.

The returns for 1902 show that during that year there were 109 establishments, in 12 different states, using a cyanide process for the extraction of the precious metals from tailings or ores. Of these establishments, 29 cyanided the ore or tailings without other treatment; 27 crushed the ore previous to cyaniding; 5 concentrated the ore; 20 combined amalgamation for coarse gold with cyaniding for the finely divided gold; 18 combined concentration and amalgamation with cyaniding; 6 combined smelting, and in some instances amalgamation with cyaniding; and 4 combined chlorination, with and without amalgamation, with cyaniding. During the census year these establishments treated 3,089,673 tons of ore and 199,689 tons of old tailings, or 3,289,362 tons in all, and produced 776,050 fine ounces of gold, valued at $15,972,268, and 1,741,546 fine ounces of silver, valued at $871,878; the products included also 15,000 pounds of copper, valued at $1,670; 741,000 pounds of lead, valued at $12,494; and 8,726 pounds of mercury (recovered from tailings), valued at $5,620, so that the total value of all the products was $16,863,930.

The returns showed directly that of the total output of precious metals 289,305 ounces of gold, valued at $5,947,888, and 559,872 ounces of silver, valued at $287,614, were extracted from 1,156,643 tons of ore and tailings by means of some cyanide process of recovery. It is estimated that in those operations in which amalgamation, chlorination, smelting, or several of these processes were combined with a cyanide process, gold to the value of $2,000,000 and silver to the value of more than $300,000 were recovered by cyanide processes. Hence, by the use of such processes there were produced in the United States, in 1902, gold with an estimated value of about $8,000,000, and silver with an estimated value of about $600,000.

A detailed summary for cyaniding mills is presented in the report on gold and silver.

OCCURRENCE OF GOLD.

Gold, when found *in situ*, is generally in quartz veins intersecting metamorphic rocks, and to some extent in the wall rock adjoining these veins. It may occur either free or combined apparently with tellurium and perhaps selenium, and it is associated with pyrite (iron disulphide), chalcopyrite (copper-iron sulphide), galena (lead sulphide), sphalerite (zinc sulphide), mispickel (iron sulph-arsenide), and many other minerals containing sulphur, antimony, bismuth, cobalt, nickel, the platinum group of metals, etc. On exposure to the atmosphere these minerals may undergo chemical changes, whereby many of their constituents are converted into other compounds, while the metallic gold is set free. Atmospheric action also breaks the veinstone into fragments, which are ground to smaller particles by attrition. When suspended in flowing water the superior density of the gold causes the particles, together with the heavier particles of the vein matter, to settle out, through a natural concentrating action, in an obstructed portion of the stream, forming alluvial deposits or placers. Through geologic changes such alluvial deposits may again be formed into rock masses, the gold being found in conglomerate rock cemented together by finely divided material, which may be barren or may itself contain gold. When the gold occurs free in quartz or in a weathered vein, it is called a free-milling ore; when it is intimately associated with sulphurets and similar substances, it is called a refractory ore.

Free gold, as found in nature, is never pure, being alloyed to a greater or less degree with silver, copper, and other metals. It occurs in quartz in the form of strings, scales, or plates, and at times in considerable masses of aggregated crystals; the scales are often so small as to be invisible to the naked eye, so that quartz showing no "color" and no evidence of gold on panning may yet yield a considerable percentage on assay. The metal is very irregularly distributed through the quartz, being disseminated throughout its mass, and also occurring in cavities; it is in these cavities that the largest masses and most perfect crystals of gold are found. Alluvial gold occurs usually in flattened scales of different degrees of fineness, the size and shape depending partly on its original condition in place, and partly on the amount of attrition it has undergone in transport. The average fineness of the gold in a placer is determined by the assorting action of the running water that transported the materials from their point of origin; the coarser particles, requiring rapid currents to transport them, are dropped first, while the finer particles are carried long distances, sometimes scores of miles. Another agent which has borne no inconsiderable part in this transportation, delivering its burden to the streams at its base, is the glacier.

MINING AND RECOVERY OF GOLD.

Placers.—In the earlier operations in auriferous districts, the gold is obtained from the placers by the use of the pan, rocker bumper, "long tom," and sluice, and by hydraulicking. The hydraulic process was employed by the Romans, but it has probably reached its greatest development in this country, since its introduction in California in 1853. In this process, as in the workings of nature, the energy of a head of water dislodges the gold bearing detritus, and the buoying power of water at different rates of flow separates the heavier from the lighter particles. Even in ancient times, these methods were often supplemented by the use of mercury, either in the liquid state or exposed on plates, to catch and retain, by amalgamating with them, the lighter particles of gold, which would otherwise flow away with the dirt. More recently, dredging has been resorted to in order to recover the gold bearing alluvium from river beds, and even from deposits in former river beds, over which have since formed deposits of silt so deep that the water has been turned from its course.

Free milling ores.—When the placers have been exhausted, attention is given to the recovery of the gold *in situ* by vein or quartz mining. As long as the ore is free milling, the process consists in detaching it from the vein by drilling and blasting. It is then crushed by stamps, crushers, or rock breakers, and treated, like placer deposits, by sedimentation and amalgamation. The machinery and devices used for concentration, separation, and amalgamation have been very highly developed, especially during the past century. During the last half century treatment by chlorine has been resorted to for the recovery of the fine gold.

Refractory ores—old methods.—When refractory ores are reached, the methods of mining are changed. Before the introduction of the cyanide process, the gold in these ores was extracted by smelting, chlorination, or other elaborate chemical process, the degree of success depending on the richness of the ore in precious metals or in other materials that would yield a profit on the operations. Thus the precious metals associated with galena were alloyed with the lead reduced from it by smelting, and subsequently recovered by processes such as that of Parkes or Pattison; iron pyrites carrying the precious metals were roasted to convert their sulphur content into sulphuric acid, and the precious metals were then recovered from the pyrite cinder, and these methods are still employed. Copper pyrites, which usually carries gold and silver, and has long been a source from which these metals were obtained, has become a notable source of supply, since the development of Manké's method of bessemerizing copper mattes and the successful refining of this impure copper by electricity. These are a few among numerous methods proposed or used for the treatment of refractory ores. In the development of the milling processes it has become possible to assort the ore into different concentrates, each of which is treated by that process which will most effectively and economically extract the gold and other valuable substances present.

On account of the cost of transportation or treatment, however, at many mines only the most valuable of the ores could be worked profitably; moreover, after the greatest possible value had been extracted by concentration or by some other comparatively crude form of treatment, the tailings—carrying with them, in the aggregate, much gold and silver—were disposed of as inexpensively as possible. Thus, in the early days of the Comstock lode in Nevada, which has yielded gold and silver valued at more than $400,000,000,[1] the treatment of the ores was limited to mill batteries, amalgamating pans, and settlers, the tailings—still containing notable quantities of the precious metals—being deposited in the canyons leading to the Carson river. Later, blanket sluices, riffles, and other devices were employed to catch the rich sulphurets that had escaped previous treatment, as well as quicksilver and amalgam from the plates; in addition, restraining dams and reservoirs were constructed at favorable points in the two canyons, and along the edges of the river, to catch the tailings and the rich chloride slums or settlings, but both the dams and their accumulations were sometimes swept away by winter floods. Since the erection, in recent years, of several cyanide plants at Silver City and Six Mile Canyon to work these tailings, it has been estimated, on the basis of the values recovered from the tonnage work, that the value of the precious metals swept into the river and spread over its erratic bed and sandy flats aggregated $60,000,000. This estimate is supported by the results obtained in attempting to recover some of these values from the river bed by dredging and other means.

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[1] Report of the Director of the Mint upon the Production of the Precious Metals during 1902, page 158.

All of the long-used methods have been open to criticism with regard to efficiency or economy. Thus, in the working of placers or free milling ores, sometimes the finest particles of gold were not precipitated by the riffle bars or caught on the blankets, but floated away with the slimes; again, the grains of gold were often "rusty," or so coated as to refuse to amalgamate when brought in contact with the mercury, and hence, in spite of the use of metallic sodium, or of potassium cyanide and other chemicals, much gold escaped; or the presence of lead, copper, arsenic, antimony, or other substances in the ore caused the mercury to become "foul," and therefore unable to take up gold. These, combined with other causes of loss, have led to the estimate that although gold to a value of over $1,000,000,000 has been produced in California since 1848, "yet more has been wasted in milling and hydraulic mining by being washed down the rivers and even to the ocean."

Such were the conditions that existed in 1888, when, by tests made on a large scale, it was demonstrated that the cyanide process for the recovery of gold and silver from low-grade ores was of practical value and low cost, making it possible to work profitably the large bodies of low-grade ore scattered over the earth, and the enormous piles of tailings accumulated around both abandoned and active mines and mills and being continually added to as mining and milling proceeded.

THE CYANIDE PROCESS.

History.—According to Hoefer,[1] prussic acid appears to have been known to the Egyptian priests, who used it for poisoning initiates guilty of divulging the sacred mysteries. According to Eissler,[2] the fact that gold when in a fine state of division was soluble in cyanide of potassium was already known in the Middle Ages, when the gilding of metals was carried out by jewelers and alchemists by the use of gold in cyanide solutions. Unless potassium cyanide was at that time made from prussic acid obtained from vegetable sources, it is difficult to reconcile this with the statements made by Watts, by Roscoe and Schorlemmer, and other authorities, that potassium ferrocyanide was discovered by Macquer in 1752 and hydrogen cyanide by Scheele in 1782; for these, particularly the former, are the present sources of potassium cyanide. It has long been known, however, that in the kernels of the bitter almond, peach, apricot, plum, cherry, and quince, in the blossoms of the peach, sloe, and mountain ash, in the leaves of the peach, cherry laurel, and Portugal laurel, in the young branches of the peach, in the stem bark of the Portugal laurel and mountain ash, and in the roots of the mountain ash, there occur certain glucosides which, through the action of an enzyme in the presence of water, become hydrolyzed, yielding hydrogen cyanide, or prussic acid, as one of the products.

The solubility of gold and silver compounds in cyanide solutions was demonstrated by Scheele on pages 405 and 406 of his chemical essays. According to Gore,[3] it was the reading of this passage in Scheele's work which in 1840 suggested to John Wright, of Birmingham, England, the suitability of cyanides of gold and silver, dissolved in solutions of alkaline cyanides, for use in electroplating. This plan was immediately tested with solutions of silver, first in potassium ferrocyanide and later in potassium cyanide, and the results were so successful that this method of electroplating was embodied in a British patent issued to G. R. and H. Elkington, March 25, 1840. This patent became the basis of the arts of electro-silvering and electro-gilding which have been so extensively practiced ever since. It was in 1840, also, that the solubility of the metals themselves was taken advantage of, for in Mason's "separate battery," devised in that year, the necessity of supplying additional metallic salt to the bath as the deposition went on was obviated by the use of an anode composed of the metal to be deposited on the object suspended at the cathode.

In "The Cyanide Process, its Practical Application and Economical Results,"[4] Scheidel says:

> The first record, in scientific literature, of experiments in which metallic gold was dissolved in a cyanide of potassium solution consists in Prince Pierre Bagration's paper in the Bulletin de l'Academie Imperiale des Sciences de St. Petersbourg, 1843, tome 11, page 136. Bagration, who alludes to Elkington's process, preserved cyanide of potassium solution in a dish gilded on the inside. He noticed that after eight days the whole gold surface had been attacked. He experimented then with finely divided gold under the influence of the galvanic current. The latter he soon recognized as not of any benefit in the dissolving process. He precipitated the gold out of the cyanide solution by means of the electric current on a cathode of copper. Continued experiments proved the advantage of higher temperature during the dissolving process, and taught the precipitation of gold from its still warm solution by means of silver or copper plates, without the electric current. The higher temperature had, however, the disadvantage of the silver and copper being strongly attacked by the cyanide solution during the precipitation process. Bagration extended his experiments to solutions of ferrocyanide, which he found to act like cyanide, but in a much less degree. He further studied the solubility of gold in the form of plates in cyanide and found it to be dissolved in such form at a considerable rate at a temperature of 30° to 40° C. He noticed the influence of the air on the reaction. Bagration believes that hydrocyanic acid in a state of generation is a gold solvent, and he concludes his paper with the remark that in the future cyanide of potassium must be enumerated among the solvents of gold. L. Elsner published in J. fr. Chem., 1844, page 441, his observations on the reactions of "reguline metals" in an aqueous solution of cyanide. He found that gold and silver were dissolved in potassium cyanide without decomposition of water. "The dissolution of the metals is, however, the consequence of the action of oxygen which, absorbed from the air, decomposes part of the cyanide." His reaction has been expressed by others in the following equation:
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> $$\underset{\text{(Gold.)}}{2\,Au} + \underset{\substack{\text{(Cyanide of}\\\text{potassium.)}}}{4\,KCy} + \underset{\text{(Oxygen.)}}{O} + \underset{\text{(Water.)}}{H_2O} = \underset{\substack{\text{(Auro-potassic}\\\text{cyanide.)}}}{2\,AuKCy_2} + \underset{\substack{\text{(Potassic}\\\text{hydrate.)}}}{2\,KOH}$$

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[1] Histoire de Chemie, Vol. I, page 226.

[2] The Metallurgy of Gold, 1896, page 378.

[3] The Art of Electro-metallurgy, 1877, pages 19 and 20.

[4] California State Mining Bureau, Bulletin No. 5, 1894, page 9.

It is generally called Elsner's equation. Some years after, Faraday made use of the solubility of gold in cyanide solution for reducing the thickness of gold films. (Experiments on the relations of gold and other metals to light, Transactions of the Philosophical Society, 1857, page 147.) The basis of the most modern process for the extraction of gold was thus provided.

In confirmation of Elsner's theory as to the action of oxygen, which has been disputed, it may be noted that V. Lehner has recently shown[1] that gold will dissolve in common acids, like sulphuric and phosphoric, if oxygen be present in the solution, and that the solubility of gold in selenic and telluric acids is due to the fact that at the temperature which obtains in the reaction these acids are themselves broken up into dioxides and oxygen.

The first instance of an attempt to apply this solvent action of the cyanides to the extraction of precious metals from their ores or other bodies containing them appears in United States Patents 61866 and 62776, issued to Dr. Julio H. Rae, of Syracuse, N. Y., on February 5 and March 12, 1867. Dr. Rae claimed the use not only of potassium cyanide as a solvent for the precious metals in the ore, but also of an electric current in precipitating them from the solution, and of rotatory or movable electrodes. This was followed by United States Patent 229586, of July 6, 1880, to Thomas C. Clark, of Oakland, Cal., who roasted his ore to a red heat, and placed it, in this condition, in a cold bath containing salt, prussiate of potash, and caustic soda; United States Patent 236424, of January 11, 1881, to H. W. Faucett, of St. Louis, Mo., who subjected hot crushed ores, under pressure, to the action of sodium cyanide in solution; and United States Patent 244080, of July 12, 1881, to John F. Sanders, of Ogden, Utah, who treated his ore with potassium cyanide and glacial phosphoric acid. But in each of these last three patents the object was to cleanse the gold previous to amalgamation, potassium cyanide having been used for a considerable time, in California and Australia, for removing the coatings from rusty gold in the pan amalgamation process.

In 1884 Astley P. Price applied for British Patent 5125, for the use of zinc in a state of fine division in precipitating gold or silver from solutions containing them. On July 28, 1885, United States Patent 323222 was issued to Jerome W. Simpson, of Newark, N. J., covering the extraction of gold, silver, and copper from their ores by means of solutions containing potassium cyanide, ammonium carbonate, and sodium chloride, and the subsequent precipitation of the dissolved metals by means of pieces or plates of zinc suspended in the solution. A caveat for the use of cyanide was filed in the United States Patent Office by F. M. Endlich and N. W. Mühlenberger, during the same year, but was subsequently abandoned. At Park City, Utah, about the same time, Louis Janin, jr., made experiments with cyanide in extracting silver and gold from ores, which led to his filing a caveat on May 1, 1886. He did not press this to an issue, but he published his results in the Engineering and Mining Journal, 1888.[2] W. A. Dixon also made experiments with cyanide on Australian ores, and recorded his results in a paper read before the Royal Society of New South Wales.

The cyanide process acquired commercial value in 1887, when John S. MacArthur and W. Forrest, of Glasgow, Scotland, applied, on October 19, for their English patent covering the use of dilute solutions of cyanides in the extraction of the precious metals. Later they obtained a patent for the use of zinc as a precipitant in a particular state of subdivision.

The commercial value of the cyanide process was demonstrated by tests made on a large scale, with ore from the New Zealand Crown mine, in June and July, 1888. Commercial success dates from the introduction of the MacArthur-Forrest process, in 1890, in the Witwatersrand gold fields in South Africa, the first cyanide plant in the world for treating tailings having been erected at Johannesburg in April, 1890.[3] In the Witwatersrand alone, at the end of 1891, there were 6 companies treating tailings by the cyanide process; at the end of 1892 there were 22; and at the end of 1893 there were 32, with a record of 143,500 tons per month treated. By the use of this process there were recovered in the Rand 286 ounces of gold in 1890, 34,862 ounces in 1891, 178,688 ounces in 1892, 330,510 ounces in 1893, 714,122 ounces in 1894, 753,490 ounces in 1895, and 703,704 ounces in 1896; the output then increased up to September, 1898, when the commencement of active hostilities in the Boer War interfered with the active working of the mines.

Methods.—The cyanide process consists in lixiviating the finely powdered ore with a dilute solution of an alkali cyanide, drawing off this solution when charged with the precious metals, and precipitating these metals from the solution. In the patents of MacArthur and Forrest the claims were made for the use of dilute solutions of cyanide (not more than 8 parts of cyanogen to 1,000 parts of water); the employment of caustic alkalies for neutralizing acid ores, prior to their digestion in the cyanide solution; and the use of zinc, preferably in a filiform condition, as a precipitant. The cyanide first used was potassium cyanide, but cyan-salt, which is a mixture of sodium and potassium cyanides, has come into extended use. The tailings, or a charge of ore crushed to the desired fineness, are placed in the leaching vats or tanks and, if acid, given a preliminary treatment with lime or sodium hydroxide, which is generally washed out before further treatment. The ore is then subjected to the action of the cyanide solution, which is usually admitted at the bottom of the leaching vat; after digesting for a length of time, depending on the character of the charge, its fineness, its freedom from slimes, and the strength of the cyanide solution, the solution containing the precious metals is drawn off and the operation repeated. According to Elsner's equation and the elaborate investigations of MacLaurin and Christy, the presence of oxygen in the solution is essential, hence many operators use sodium peroxide or other oxidizing agents with their cyanide solutions.

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[1] Journal of the American Chemical Society, 1904, Vol. 26, pages 550 to 555.

[2] Page 548.

[3] Alfred James, Cyanide Practice, frontispiece, 1902.

The leaching or percolation vats vary much in form, dimensions, and construction. Thus they may be of wood, barrel-shaped, 22.5 feet in diameter and 4 feet deep, and holding a charge of 30 tons; or of concrete, rectangular, 50 by 40 feet in area and 4 feet deep, and holding 150 tons.

The following facts from Packard's paper on "The Cyanide Process in the United States"[1] indicates the wide ranges of variation in methods:

In the Mercur district the ore is covered with solution, which is allowed to stand from thirty minutes to six hours and then drawn off. This operation is repeated from eight to thirty-five times. Here the material leached is so coarse that there is no danger of "packing." Each operation of covering takes from two to six hours. A few mills cover the pulp with solution, allow it to stand forty-eight to ninety-six hours, draw it off, and wash. Many of the mills follow the strong solution with a wash of weak solution (one-tenth per cent or less). This is in turn followed by a water wash, which flows through the zinc boxes into the weak solution tank and becomes the first wash for the next charge.

In the extraction processes referred to above the treatment with cyanide solutions is accomplished by percolation. This method is widely and successfully used, but it has its disadvantages. If the material treated is a clean sand, the solution penetrates throughout the mass, exerting its full solvent effect, and the subsequent draining and washing are easily accomplished. But if the ore contains some kind of rock which is converted by the crushing into a powder that when moistened produces slimes—a formation which is most marked when the rock is of a clayey nature—the presence of these ore slimes in the leaching vats may retard or even prevent percolation, according to their amount and character. In working ores of this kind, the difficulty has been obviated by coarse crushing, but in that case gold is lost, because the solvent can not penetrate through the coarser granules of ore to the inclosed grains of metal. To overcome these defects in the process, resort is had—as in the Pelatan-Clerici process, or in the use of the Aurex sluice—to agitation during exposure to the cyanide solution. Furthermore, since in these processes amalgamation and precipitation are carried on nearly simultaneously with solution, not only is the coarse gold quickly removed, but the rusty gold is made capable of amalgamation through being cleansed by the action of the cyanide and the electric current, which are employed simultaneously, while the float gold is either amalgamated directly or dissolved and then precipitated. In these processes the precious metals are recovered as amalgams, which need only retorting and melting to be ready for the mint.

A novel method of overcoming the impermeability of slimes is found in the suggestion of Count von Schwerin,[2] who proposes to remove water from wet clay and similar amorphous fine slimes by passing through the mass an electric current, whereby the water is driven to the cathode and the solid particles to the anode by "electric endosmosis." The apparatus consists of a wooden vat having for a bottom a brass netting, which forms the cathode; the water being drawn to the netting quickly runs off.

In the MacArthur-Forrest process, the cyanide solution containing the gold and silver is next run into zinc boxes for the precipitation of the precious metals. The zinc boxes, like the leaching vats, vary in character at the different works. A form in common use in the United States is made of 2-inch dressed plank, bolted together and painted with paraffin paint; it is divided into six compartments, 13 by 20 inches in cross section and 20 inches deep, and is provided with a screen about 4 inches above the bottom, on which to place the zinc shavings. About sixty pounds of shavings are required to fill the box. It is provided with an inlet and an outlet pipe, and in the bottom of each compartment is placed a 1-inch pipe closed with a stopcock, through which the slimes are drawn off in cleaning up. The circulation in the zinc box is secured by having the first partition of a compartment extend from the top of the box to within 3 inches of the bottom, while the second partition extends from the bottom of the box to within 2 inches of the top. The screen for the zinc shavings is stretched between. The solution from the entrance pipe falls to the bottom of the box, passes under the first partition, rises up through the zinc shavings, flows over the second partition, and thus proceeds up and down from compartment to compartment until it reaches the exit pipe of the box. The Mercur mill is equipped with long sheet-iron boxes having wooden partitions wedged into place; these can easily be removed for cleaning up, the slimes being all brushed together. At the Cripple Creek mill, the slime discharge pipes of the zinc boxes lead from the side of each compartment and discharge the slime into a trough leading to a tank.

When the potassium cyanide solution comes into contact with the gold in the leaching vat, the gold is dissolved, forming potassium aurocyanide, according to the following equation:

$$4\,KCy + 2\,Au + O + H_2O = 2\,KAuCy_2 + 2\,KHO.$$

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXVI, pages 709 to 721.

[2] Zeitschrift der Elektrochemie, 1903, page 739.

According to Christy,[1] when the solution of potassium aurocyanide, containing, as it usually does, an excess of potassium cyanide, is brought into contact with the zinc, the reaction may be represented by

$$2\ KAuCy_2 + 3\ Zn + 4\ KCy + 2\ H_2O = 2\ (ZnCy_2\ .\ 2\ KCy) + K_2O_2Zn + 2\ H_2 + 2\ Au;$$

but in the absence of free potassium cyanide the successive reactions taking place may be summed up in the following equation:

$$4\ KAuCy_2 + 4\ Zn + 2\ H_2O = 2\ ZnCy_2 + ZnCy_2\ .\ 2\ KCy + K_2O_2Zn + 2\ H_2 + 4\ Au.$$

Christy also says:

> According to the substitution reaction, one atom of zinc replaces two atoms of gold, or 1 ounce of zinc should precipitate 6.2 ounces of gold; whereas, as everyone knows, in practice 1 ounce of zinc will precipitate only one-fifth to one-fifteenth of an ounce of gold, or thirty to ninety times less than the amount called for by the reaction by substitution. According to the reactions I have suggested, in the absence of free cyanide of potassium and caustic potash 1 ounce of zinc should precipitate 3.1 ounces of gold; in the presence of a moderate excess of cyanide of potassium it should precipitate 2.06 ounces. The apparent discrepancy that seems still to remain between theory and practice is in reality due to the facts, first, that the free alkali (potash in particular) formed in the solution of the gold, or added to neutralize the free acid in the ore, also dissolves the zinc as potassium zincate; second, that an excess of potassium cyanide dissolves the zinc on its own account, both as the double cyanide and as the zincate of potassium; third, it should also be remembered that water containing dissolved oxygen attacks metallic zinc quite vigorously, forming hydrate of zinc.

According to Packard, the 60 pounds of zinc shavings required to fill the zinc boxes described above will precipitate the gold from about 1,500 pounds of 0.2 per cent solution per hour, the solution carrying from 0.1 to 0.8 ounce of gold per ton on entering the zinc box, and from 0.01 to 0.05 ounce on leaving it. The gold in wash waters and weaker solutions is less easily precipitated, a much longer contact with the zinc being required.

On cleaning up, the zinc shavings are washed and the finely powdered portions, called zinc-gold slimes, are screened through sieves varying in mesh, at the different mills, from one-fourth-inch mesh to 60-mesh, the coarse stuff being returned to the zinc box. In this country, where the zinc-gold slimes are treated at the mills, they are subjected to the action of an acid, such as sulphuric, which removes much of the zinc and other soluble bodies, and the residues are then washed, dried, fluxed, and melted. A few mills ship these slimes to smelters and refiners, but the difficulty of obtaining a satisfactory sample, and the almost constant wide disagreement between buyer and seller have led many smelters to refuse to handle them.

In discussing Professor Christy's paper Mr. Francis L. Bosqui stated[2] that at Bodie, Cal., after many discouraging failures, the following method of operating in treating the zinc-gold slimes was adopted, and has been followed with entire success:

> The slimes and fine zinc are discharged directly from the zinc boxes into a redwood vat 6 feet in diameter and 2 feet deep. This vat is protected on the inside by several coats of paraffin paint, has a slight bottom incline for drainage, and is provided with a 2-inch discharge valve. Here the slimes are treated with sulphuric acid. After the destruction of the zinc, the zinc sulphate and the slight excess of acid present are diluted by filling the vat with warm water. Within an hour the bulk of the precipitate will have settled to the bottom. The supernatant liquor, to the amount of about 400 gallons, which still contains a small amount of gold slimes in suspension, is then siphoned off into a 10-ton settling vat.
>
> The gold slimes are treated with a succession of these washes, the supernatant liquor being each time drawn off into the settling vat, until the amount of zinc sulphate remaining in the slimes is insignificant. The liquor siphoned off into the settling vat, which contains only a very small quantity of slimes in proportion to the total quantity obtained, is left to settle between clean-ups. The clear liquor is drawn off just before a succeeding clean-up, and at long intervals the precipitate is gathered from the bottom and melted.
>
> The bulk of the slimes is finally discharged from the acid vat into a filter box. This box is provided, about a foot from the top, with a perforated partition which is closely covered with two thicknesses of ordinary mill blanketing. From the compartment beneath this filter the air is withdrawn by means of a steam ejector, and the water is thus removed from the slimes by suction. At the bottom of the box is a 1-inch discharge valve for drawing off the accumulated clear liquid. By occasionally scraping the filter blankets the passage of water through them is greatly facilitated. These blankets are removed and washed after each clean-up, and clean ones are substituted. The partially dried slimes from the blankets are then completely dried over a furnace and melted in crucibles. The zinc residues being thus pretty thoroughly removed from the slimes, the difficulties in melting are reduced to a minimum. * * *
>
> For some time a considerable value went into the slag, which had to be shipped to the smelting works. But after a good deal of experimentation a very suitable flux has been found, which reduces the slag value to almost nothing. A dust chamber has been constructed in connection with the melting furnace, and an effective damper introduced in the course of the flue. The latter is closed at each charging of the crucible, and "dusting" is thus almost entirely avoided.
>
> Our loss in melting has never been more than barely appreciable, and now, since the introduction of a dust chamber and damper, is wholly insignificant. The wonderfully close correspondence between our actual bullion yield and the extraction indicated by careful assays of charged and discharged tailings would in itself weaken the supposition of any considerable loss in melting. To be sure, our bullion is low grade, but we suffer no inconvenience from this except the small increase in cost of transportation and refining in proportion to the value of the bars.

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXVI, pages 735 to 772.

[2] Transactions of the American Institute of Mining Engineers, Vol. XXVII, pages 837 to 846.

Precipitants other than filiform zinc are sometimes employed to throw down the gold. Thus, at the Delamar mine, Nevada, the precipitation is by zinc dust,[1] with agitation: Molloy precipitates with sodium or potassium amalgam, Moldenhauer with aluminum, Johnston with pulverized carbon, Christy with cuprous chloride, and De Wilde with cupric sulphate. Precipitation is effected also by electricity, amalgamated copper plates being used in the Pelatan-Clerici process, and thin lead plates as cathodes, with iron anodes, in the Siemens-Halske process.

Electro-deposition processes seem to possess an advantage over zinc precipitation processes in that the presence of caustic soda makes no difference in the result, and that they are as effective with a weak as with a strong solution. Very weak cyanide solutions may therefore be used in the leaching vats. Charles Butters, who has been closely identified with the development of the cyanide process from its introduction into this country in practical form, and has had extensive professional experience in South Africa, says[2] that in our more modern plants the electrolytic and zinc processes are now used in combination for the recovery of the metal from cyanide solutions. The solution is first cleaned by the electrolytic process. It extracts from 90 to 94 per cent of all the products, including practically all of the copper. About 8 to 9 per cent of the electric box capacity is then filled with zinc, which, aided by the electric current, removes the small quantities of gold and silver remaining. By this combination the zinc is constantly at its best, as everything that would injure the surface of the zinc as a precipitating surface has been eliminated by the previous electrolytic treatment. At Butters' mines, in Salvador, an extraction of about 99 per cent of the values in solution is made on regular monthly runs. This process is used also at Virginia City, Nev., and at Minas Prietas, Mexico.

The following tables from Packard's paper clearly set forth some of the variations which obtain in the use of the cyanide process with precipitation by zinc in practice, with the results:

Description of ores used in cyaniding, with precipitation by zinc.

MILL AT—	CHARACTER.	COMPOSITION.					
		SiO_2.	Fe.	Al_2O_3.	$CaCO_3$.	S.	Other elements.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Mercur, Utah	Porphyry and limestone	70 to 80		5 to 10			As, Hg.
Sunshine, Utah	Decomposed porphyry and quartz	70 to 80		5 to 10	12 to 15	Little.	As, Sb, Te.
Bingham, Utah	Sandy quartz, with iron oxidized from sulphides and bunches of lead carbonate.				Little.		As, 0.2 per cent; Cu; much free acid.
Gilt Edge, Mont	Porphyry and limestone						
Cooke, Mont	Decomposed porphyry	84	3.6	2.6	[1]0.6	0.3	
Black Hills, S. Dak	Silica, with iron in varying conditions	80 to 96	Varies.			Varies.	Traces of Cu, Mn, As, Sb, Te.
Cripple Creek, Colo	Porphyry				[2]1 to 3	Small.	

[1] Calcium. [2] Calcium oxide.

Methods of treatment and results in cyaniding, with precipitation by zinc.

MILL AT—	Capacity, tons per day.	Size of ore leached mesh.	Preliminary treatment.	Strength of cyanide solutions.	Number of hours leached.	Cyanide consumed per ton of ore treated	Zinc consumed per ton of ore treated.	ASSAY OF ORE.		Extraction of gold	Cost per ton.
								Gold.	Silver.		
		Inches.		*Per cent.*		*Pounds.*	*Pounds.*	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	
Mercur, Utah	200	[illegible]	None	0.20 to 0.25	48	0.60		0.5 to 6.0		80 to 87	$0.85
Sunshine, Utah	60	[illegible]	Lime	0.06 to 0.20	48	0.75	0.30				
Bingham, Utah	40	[illegible]	Sodium dioxide	0.025 to 0.125	120	1.0	0.30	0.25	2.0	80	1.85
Gilt Edge, Mont	50	20	None	0.15	72	0.2	0.25	0.45		75	1.25
Cooke, Mont	25	16-20	Lime	0.25	48	1.5 to 2.0	0.25	Variable.			
Black Hills, S. Dak	[illegible]	30	Lime	0.50 to 0.75	96	1.25		0.3 to 0.9		85	2.50
Cripple Creek, Colo	75	40	Various, lime	0.05 to 0.75	100	1.0 to 2.0	0.25 to 0.50	1.0	0.2	90	

Mr. W. H. Davis has discovered that by subjecting foul cyanide solutions to the action of alternating electric currents the solutions are not only regenerated, owing to the precipitation of the foul matter present, but the resultant solution is more active and has a higher solvent power than a normal cyanide solution. He attributes this increased efficiency to cyanogen which has been set free in the electrolysis, being held dissolved in the solution. This process of treatment was introduced on a working scale at the Smuggler-Union mines, Colorado, in May, 1902, and it is claimed that by its use tailings carrying as low a value as $1.80 per ton have been treated at a profit, the average cost of treatment being 50 cents per ton. The published statement[1] of the manager of these mines, comparing the results of the operations for the four months preceding with those for the four months succeeding the introduction of this process for regenerating the foul solutions, states that the application of the process resulted in a reduction of 29.73 per cent in the quantity of potassium cyanide consumed and an increase of 17.09 per cent in the quantity of gold and of 4.81 per cent in the quantity of silver extracted.

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[1] S. F. Emmons, Transactions of the American Institute of Mining Engineers, Vol. XXXI, pages 658 to 683.

[2] Electro-chemical Industry, Vol. II, page 207.

The results of simultaneous cyaniding, agitation, amalgamation, and electro-deposition are set forth in the following table, given by T. M. Chatard and Cabell Whitehead:[2]

Results of simultaneous cyaniding, agitation, amalgamation, and electro-deposition.

ORE USED.	Screen mesh.	Length of run.	ORE ASSAY.		TAILINGS ASSAY.		EXTRACTION.		STRENGTH OF CYANIDE SOLUTION.			ELECTRIC CURRENT.	
			Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Start.	End.	Loss.	Volts.	Amperes per square foot.
		Min.	*Ounces.*	*Ounces.*	*Ounces.*	*Ounces.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		
Heavy (60 per cent) sulphuret ore, North Carolina	60	75	1.075	1.23	0.20	0.60	81.41	51.00	0.131	0.064	0.067	1.86	0.20
Telluride ore, oxidized, very slimy, Cripple Creek, Colo	60	60	0.90	0.60	0.10	0.35	88.90	42.00	0.190	0.155	0.035	2.10	0.17
	60	45	0.90	0.60	0.10	0.45	88.90	33.00	0.184	0.152	0.032	2.01	0.23
Telluride, like No. 2, Cripple Creek, Colo	60	60	0.95	0.65	0.12	0.38	87.47	41.51	0.185	0.134	0.051	2.20	0.26
	60	60	0.95	0.65	0.07	0.28	92.63	56.92	0.250	0.164	0.086	2.30	0.23
Telluride oxidized, dark red, very slimy, Cripple Creek, Colo	60	60	4.55	1.45	0.12	0.38	97.38	73.80	0.163	0.081	0.082	1.01	0.18
	60	75	4.55	1.45	0.10	0.25	97.81	82.76	0.164	0.129	0.035	1.80	0.19
Heavy sulphuret, Boulder county, Colo	60	60	0.40	1.30	0.12	0.60	70.00	54.60	0.150	0.059	0.091	2.02	0.22
Heavy sulphuret, South America[1]	60	60	1.05	4.35	0.60	2.55	42.86	41.38	0.180	0.078	0.102	2.02	0.23
Republic Mine, Washington	60	60	6.30	6.15	2.10	2.80	66.66	54.49	0.287	0.201	0.086	2.10	0.26
Republic Mine, finer ground	80	75	6.30	6.15	1.45	1.90	77.00	69.13	0.289	0.209	0.080	2.30	0.21
Republic Mine, still finer	100	75	6.30	6.15	0.48	1.02	92.38	83.41	0.231	0.164	0.067	2.63	0.14
Rich ore, Virginia, contains galena, etc	100	90	33.98	....	1.66	....	95.05	....	0.292	0.185	0.107	2.78	0.73
Republic Mine, Washington, mill pulp	100	90	2.50	3.75	0.40	1.55	84.00	60.00	0.170	0.105	0.065	3.27	0.67
Republic Mine, Washington, mill pulp	100	60	2.50	3.75	0.25	0.75	90.00	79.20	0.245	0.190	0.055	3.08	0.67
Republic Mine, Washington, mill pulp	100	60	2.50	3.75	0.20	2.25	92.00	40.00	0.320	0.225	0.095	3.10	0.50
Republic Mine, Washington, mill pulp	100	60	2.50	3.75	0.135	1.36	91.60	63.60	0.277	0.202	0.075	3.00	0.50
Republic Mine, Washington, coarse ore	60	60	2.30	2.50	0.375	1.025	83.70	58.80	0.198	0.099	0.099	No meter.	0.15
Republic Mine, Washington, coarse tailings	100	60	0.45	1.30	0.25	1.125	44.11	13.46	0.117	0.080	0.037	3.00	0.33
Republic Mine, Washington, coarse tailings	100	90	0.45	1.30	0.25	1.10	44.11	15.37	0.155	0.095	0.056	No meter.	0.48
Rough mill concentrates, Georgia	40	90	0.80	0.50	0.125	0.37	84.37	26.00	0.149	0.093	0.056	No meter.	0.48
Sulphuret ore, Georgia	40	90	2.68	1.00	0.27	0.50	89.92	50.00	0.276	0.214	0.062	2.8	0.57
Silver ore, Honduras[2]	100	90	0.71	72.86	0.10	6.00	85.91	91.76	0.263	0.175	0.088	4.0	0.83
Free quartz, California	100	90	0.475	0.92	0.05	0.525	89.49	44.02	0.235	0.140	0.095	2.6	0.94

[1] Contained arsenic and antimony.

[2] Contained silver chloride.

In this connection it may be noted that in Wagner's Chemical Technology[3] there is described a method of treating refractory ores, invented by W. Crookes, which consists in subjecting the powdered ore to the action of an alternating current in the presence of a solution of mercuric cyanide or of some other soluble salt of mercury.

The methods used in the Witwatersrand have been described recently by John Hays Hammond,[4] as follows:

> The following description applies to the treatment of ores in the pyritic zones. Ores from the upper (oxidized) horizons of the reefs, which constitute but a small percentage of the ores treated, require a slight modification of the process.
>
> The ground near the mines is level, and does not permit transportation by gravity; consequently the ore must be first elevated into the ore bins at the mill, and the tailings leaving the mill must be elevated for treatment by the cyanide process. This is done either by tailing pumps or, preferably, by tailing wheels. These are from 40 to 50 feet in diameter, and discharge the tailings into a launder, which, with a grade of about 3.5 per cent, carries them to the cyanide works. The auriferous pyrites are, to a large extent, taken out as concentrates by means of Spitzlutten (hydraulic classifier). About 10 per cent of the mill pulp recovered in this way consists of pyrites with coarse sand, a concentration of 10 to 1 being obtained. These concentrates are taken to tanks for separate treatment. From two to three weeks of treatment is required in order to obtain from this material a recovery of from 90 to 95 per cent of the gold it contains. A solution of about 0.25 to 0.3 per cent of cyanide of potassium is used. After passing over the Spitzlutten the tailings are run to Spitzkasten (pointed boxes), where the heavier sands are allowed to settle, while the lighter material (slimes) overflows, and is carried to the slime works for special treatment. The sands which settle in the Spitzkasten, representing about 70 per cent of the battery pulp, are continuously discharged by pipes leading from the bottom of the box, and are delivered by a hose or by an automatic revolving distributor to settling tanks, into which they are so fed as to be as thoroughly mixed as possible. This separation of the sands from the slimes has to be carefully made, so as to remove all clayey substances, the presence of which would otherwise prevent rapid percolation of the solution and the free access of atmospheric oxygen, which is essential to the solution of gold by cyanide.
>
> Most of the modern plants have a system of double treatment, the tailings being settled in the settling tanks, when they are treated, after being allowed to drain, with a weak solution of cyanide of potassium. This addition of the cyanide of potassium is made rather for the purpose of saturating the sands with the solution than for thorough leaching, which would be difficult on account of the packing of the sands as they are settled, rendering percolation difficult. After the solution has been drained off, the sands from the settling tanks are discharged into the leaching

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[1] Report of the Director of the Mint upon the Production of the Precious Metals during 1902, pages 99 to 101: 1903.

[2] Engineering and Mining Journal, Vol. LXIX, page 139.

[3] Manual of Chemical Technology, R. von Wagner, translated by W. Crookes, 1892, page 191.

[4] Transactions of the American Institute of Mining Engineers, Vol. XXXI, pages 817 to 854: 1902.

tanks, placed immediately below the settling tanks, from which they are filled from discharge doors on the bottom of the latter. For a 200-stamp plant 16 steel settling and 16 steel leaching tanks are usually employed. From 3 to 4 settling and leaching tanks are used for the treatment of the Spitzlutten concentrates above described. The settling tanks are usually 40 feet in diameter and 9 feet high. The leaching tanks have the same diameter, but usually a foot less height. The capacity of these tanks is about 400 tons of pulp each.

In the leaching tanks the pulp is subjected to three treatments with cyanide of potassium. Where the MacArthur-Forrest process is used, the strong solution contains 0.25 per cent, the medium solution 0.2 per cent, and the weak solution 0.10 per cent of KCy. In the Siemens-Halske process the solutions are weaker, namely, the strong solution, 0.10; medium, 0.02; and weak, 0.01 per cent of KCy.

The treatment requires from four to seven days. From 130 to 150 tons of solution are usually employed for 100 tons of sand. After being allowed to drain, the sands are discharged through bottom discharge doors into trucks, in which they are removed to residues or tailings heaps. Here, again, elevation is necessary, on account of the flatness of the country, and is usually effected by the endless rope system. These tailings heaps are conspicuous throughout the mining district. By reason of the heavy winds prevailing at certain seasons of the year, they are becoming a great nuisance, and the question of their future disposition is one of the problems for the mining engineer.

The cyanide solution, after being drawn off from the leaching tanks, is taken to the precipitation boxes. The gold from the strong solution is precipitated in one set and that from the weak solution in another set of boxes. Precipitation is effected by either the MacArthur-Forrest or the Siemens-Halske process.

The MacArthur-Forrest process.—In this process the gold is precipitated by zinc, the solution passing upward through a succession of compartments, in which are placed zinc shavings or filings, resting on a movable tray of coarse screening. About twenty precipitation boxes, 20 feet by 3 feet by 3 feet 9 inches in size, are used. The gold bearing solution is brought into close contact with the zinc, causing the deposition of the gold, partly as a metallic coating on the zinc and partly as gold slimes, which sink to the bottom of the box. As the zinc is gradually dissolved by cyanide more is added.

Once or twice a month the boxes are emptied, and the gold slimes are treated with dilute sulphuric acid, then dried and melted in crucibles. The dried slimes contain about 15 to 20 per cent of gold, and after fluxing with borax and soda an ingot of 0.750 to 0.800 fineness in gold and 0.100 in silver is obtained. The slag, carrying from 5 to 50 ounces of gold per ton, is usually sold to smelters.

This precipitation process yields satisfactory results only with solutions containing more than 0.1 per cent of cyanide, the weaker solutions not being acted upon by zinc. An improvement of the method is the addition of lead to the zinc, whereby the combination of the two metals forms a galvanic couple, which also reacts with weaker solutions, such as are employed, for example, in the treatment of slimes.

The Siemens-Halske process.—In this process the solution flows through compartments very similar to the zinc boxes above described, but the zinc shavings are here replaced with lead strips (0.1 pound per square foot) or shavings hung between iron plates placed vertically and longitudinally in the box, about 4 inches apart. The lead strips are connected with the negative, and the iron plates with the positive, pole of a dynamo, and the solution is thus electrolytically decomposed, the gold being plated on the lead cathode. The iron plates are wrapped in canvas to prevent short circuiting. The current employed is from 2 to 3 volts, giving a current density of about 0.06 amperes per square foot of cathode. Once a month the lead sheets are removed and replaced, and the gold coated lead is melted and cupelled, yielding a bullion of 0.880 fine in gold and 0.100 in silver. The litharge is sold to smelters. The solutions passing through the treatment boxes are collected in tanks, and are made up to a proper strength by adding the necessary KCy.

The cost of the Siemens-Halske process is slightly greater than that of zinc precipitation, and the percentage of extraction is about the same. But the Siemens-Halske process may be applied to any solution, weak or strong.

A digest covering most of the patents issued by the United States Patent Office in certain of the subclasses of metallurgy, and subclass 15 of electrolysis, up to 1904, is given in the Appendix.

Scope. From the description of its mode of operation it is evident that the "straight cyanide process" is readily applicable to free milling ores which are free from mineral substances that would foul the solution or consume the cyanogen salt, and the gold in which is finely divided and so exposed that the cyanide solution may come in intimate contact with it. In old tailings which have been exposed for years to the action of the weather, whereby the sulphurets have been oxidized and the acids and salts formed, dissolved and washed away, there has been found much material ready at hand for immediate treatment in the simplest manner. The problem is comparatively simple, also, in the case of siliceous gold bearing deposits free from sulphurets, but the ore must be crushed, and in many instances it is more economical to concentrate it than to expose the entire mass to the action of the cyanide solution. Moreover, even in the case of neutral and otherwise suitable ores, the fine particles of metallic gold may be so enveloped in an impermeable covering—such as iron or aluminum hydroxide—as to necessitate a preliminary treatment, such as roasting, to rupture the envelope. An example of this kind is found in the ores of the Republic gold mine, Washington, described by T. M. Chatard and Cabell Whitehead.[1] When coarse gold is mingled with the fine, it is usually more economical to separate the coarse gold by amalgamation than to await the slow-acting process of solution. With tailings in which the sulphurets are but partly decomposed and which still contain ferrous and ferric salts and sulphuric acid, cyaniding may be preceded by washing and neutralization.

The treatment of refractory ores is determined, in each case, by the chemical and physical characteristics of the ore under consideration. Hence, we find that cyaniding may be combined not only with crushing, roasting, concentration, and amalgamation, but also with smelting and chlorination. In some instances it is most advantageous to separate the ore into fractions, each of which is subjected to a different treatment. In fact, it is essential to success that the ore should be thoroughly examined by a competent metallurgical chemist before any investment in a plant for treatment by chemical processes is made, and also that the cyaniding process should be under chemical supervision, in order that, by assays of the ore and tailings and by analyses of the ore and the cyanide solutions as they enter and issue from the zinc boxes, and of the solvent during preparation and regeneration, a complete check may be made upon the operation in each of its stages.

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXX, pages 419 to 423.

Working costs.—It is obvious that the cost of the cyanide process will vary at the different plants, according to the variations in the chemical composition and physical structure of the ore treated, in the condition of the ore at the time of treatment—that is, whether it be in the form of sand or slimes—in the character of the process and the apparatus used; in the location of the mill with regard to the supply of ore or tailings used; and the source of power, water, materials, and labor. According to H. M. Chance,[1] in the Black Hills, S. Dak., the cost of smelting siliceous ores was between \$4.75 and \$5.75 per ton; the cost of chlorination, from \$3.50 to \$4.50 per ton; and the cost of the cyanide treatment, possibly from \$3 to \$3.75 per ton. From the Report of the Director of the Mint, for the calendar year 1901,[2] it appears that in that year there were 11 cyanide plants in active operation in South Dakota, having a united capacity of over 1,500 tons daily, and that some of these mills claim to be able to treat ore at a cost not exceeding 80 cents per ton, though the average cost is probably nearer \$1.50 per ton. Julian and Smart[3] give 21 different detailed accounts of costs at mines in Australia, Africa, and the United States, the results ranging from 2s. 1.23d. per ton by the Siemens process, in South Africa, to 17s. 1.02d. per ton by the Diehl process, in Western Australia.

Effect on the world's supply of the precious metals.—The data collected at this census deal only with the output of the United States for 1902. There are no collected data to afford a comparison of the condition of this industry in that year with the condition during any previous period since its introduction into this country, in 1891. But the consensus of evidence, as presented in current literature, indicates that the industry has been constantly growing, that new plants are going up each year, and that established ones are increasing their capacity. This is true not only of the United States, but also of Africa, Australia, New Zealand, Mexico, and the other gold producing countries; from each are coming increased supplies of the precious metals extracted from low-grade ores and tailings.

CALENDAR OF EVENTS AND DISCOVERIES RELATIVE TO THE PRECIOUS METALS.

1530–1540.	Pillage of Peru.
1547–1548.	Discovery of Guanajuato silver mines in Mexico.
1577.	Discovery of gold in Brazil.
1670.	Discovery of placers of Garazua.
1680.	Discovery of placers of Minas-Geraes.
1704–1728.	Silver mines opened in Russia.
1743.	Discovery of gold in the Ural.
1848.	Discovery of placers in California.
1848.	Introduction of Plattner's chlorination process at Reichenstein in Silesia.
1851.	Discovery of placers in Australia.
1853.	Introduction of hydraulic mining in California.
1853.	Maximum annual production of gold in California, amounting to \$65,000,000 for the year.
1858.	Introduction of chlorination process at Grass Valley, California.
1866.	Invention of dynamite.
1886.	Opening of the "banket" reef of the Rand, South Africa.
1889.	Development of Manké's method of bessemerizing copper mattes, and the successful refining of this impure copper by electricity.
1890.	Introduction of the cyanide process in the Rand, South Africa.
1897.	Discovery of placers in the Yukon.

Apart from the phenomenal annual increase in the production of gold during the period from 1841 to 1855, which includes the discoveries of the rich placers of California and Australia, the increase in the world's production during the last decade of the nineteenth century was unprecedented. It was most marked during the period from 1891 to 1895, following the opening of the "banket" reef of the Rand and the introduction of the cyanide processes, but it was continuous throughout the decade, except during the period of the Boer War, and the output of gold in 1902 exceeded that of any other year of our record except 1899. It is true that the use of the cyanide process is only one of several causes contributing to this result, but that it is an important one is indicated by the fact that the returns for this census show that the amount of gold recovered by the use of the cyanide process in the United States in 1902 exceeded that won throughout the whole world by all existing means during any year of our record up to 1661, and probably up to 1701.

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXX, pages 278 to 282.

[2] Production of the Precious Metals during 1901, page 201; 1902.

[3] Cyaniding Gold and Silver Ores, 1904, pages 372 to 381.

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APPENDIX.

DIGEST OF UNITED STATES PATENTS RELATING TO CYANIDE PROCESSES FOR THE RECOVERY OF PRECIOUS METALS.

This digest covers most of the patents included in the following classes and subclasses of the United States Patent Office classification:

Class 75.—Metallurgy.
  Subclass 18.—Solutions and Precipitation.
  Subclass 86.—Solutions and Precipitation—Apparatus.
  Subclass 185.—Cyanides.
Class 204.—Electrolysis.
  Subclass 15.—Aqueous Bath, Ores.

Some of the patents in these categories are quite foreign to the subject under consideration, and many but indirectly related to it. It has been thought, however, from the form which discussions of patent issues often take, to include the latter. The aim in making the digest has been to give such a sketch as will indicate the nature of the invention and what is claimed by the inventor, this generally being done by an actual abstract from or paraphrase of the words of the letters patent, but no responsibility is assumed for the opinions, theories, or claims thus set forth. Other related patents may have been granted which do not appear in this digest, because they are not embraced in the subclasses enumerated. Thus, the patents number 229586, to Thomas C. Clark; 236424, to H. W. Faucett; and 244080, to John F. Sanders, do not appear in this digest, because the first two are classified under subclass "Reducing and Separating—Disintegrating Ores," and the third under subclass "Reducing and Separating—Gold and Silver," and neither of these subclasses is included in this digest.

CLASS 75.—METALLURGY.

Subclass 18.—Solutions and Precipitation.

15542—August 12, 1856. W. Ziervogel. *Improvement in processes of separating silver from the ore.*

The application of water or a solution of sulphate of copper slightly impregnated with sulphuric acid instead of lead, quicksilver, or salt, hitherto used for this purpose, to the process of separating silver from copper and other ores, rendering thereby this separation easier, shorter, less expensive, and not noxious to the health of the operator.

19991—April 20, 1858. I. Gattman. *Improvement in the treatment of sulphureted ores.*

The use of sulphuric acid in connection with the hydrate, carbonate, or sulphate of potash or soda, or with any compound thereof, in the mode of working the native metallic sulphurets.

35842—July 8, 1862. J. Shaw. *Improved apparatus for saving silver from waste solutions.*

Attaching to the waste pipe of the sink or basin into which persons using silver in solutions suffer them to be wasted, a vessel so arranged and constructed that the liquids passing from the sink shall run into, through, and out of said vessel, and between the time of entering said vessel and escaping therefrom shall be brought into contact with such chemicals or metals as will cause the whole or any part of the silver contained in solution to be precipitated and retained in said vessel, while the worthless material is allowed to escape. (This patent was reissued as follows: Reissue 1651, April 5, 1864; reissue 3506, June 15, 1869; reissue 4030, June 14, 1870; reissue 4969, Division A, July 9, 1872; and reissue 4970, Division B, July 9, 1872.)

46875—March 21, 1865. W. Bruckner. *Improved process for refining amalgam.*

The application and use of bichloride of copper, or its equivalent, together with iron pyrites and salt, without reference to the exact proportions of each ingredient.

46983—March 28, 1865. G. W. Baker. *Improvement in treating ores.*

In order to produce a valuable metal or metals now almost wholly cast away in the treatment of auriferous and argentiferous pyrites, the inventor proposes to take the calcined ores as they come from the furnaces, and, having them well pulverized, subject them to the action of sulphurous acid in tanks located over the main discharge flues of his furnaces, whereby a sufficient heat may be obtained to assist in the reaction of the acid before mentioned. The sulphurous acid thus used is to be formed and collected by compelling the sulphurous vapors discharged from the roasting furnace to pass over, through, and in contact with water, so that sulphurous acid will be formed and collected in a properly arranged tank or tanks, from whence it may be conveyed to the ore tanks, and there mixed with the ore thoroughly by agitation in any manner most convenient. After the ore has been subjected to the action of the acid for a couple of hours the oxide of copper will be replaced by a sulphate soluble in water, and the oxide of iron will be partially brought into the same condition. Should there be any gold or silver held in solution these metals will be reduced to the metallic state. The solution is then drawn off by siphon or otherwise and conveyed to another tank or vat for subsequent treatment, either by cementation or precipitation for the copper and evaporation for the sulphate of iron. The ore thus treated may then be lixiviated by water to wash out all the acid, and this water, which will still hold some dilute solution of the baser metals, may be conveyed to the acid tank and used for the further formation of sulphurous acid. By this means the most concentrated solution is alone permitted to pass to the tank or vat for further treatment. It may be considered a well-settled fact that in all processes of calcination some portion of the precious metals, if such ores are under treatment, escape mechanically or in a vaporized form. This loss, great or small, as the case may be, has heretofore been to a great degree irreclaimable. It is claimed as a part of this improvement that such loss, whether mechanical or in the form of vapor, is wholly prevented by arresting their escape and returning them, either in solution or in the sediment of the liquid acid, to the ore when treated in the ore tanks.

47286—April 18, 1865. W. L. Faber. *Improved process of working silver ores.*

The invention consists in a process which is divided in eight different manipulations, viz, smelting the ore, pulverizing, roasting at low heat, extracting sulphates with water, roasting residue with salt, melting with soda, precipitating silver, precipitating copper.

49637—August 29, 1865. S. F. Mackie. *Improved process for treating ores.*

The mode of obtaining a rich gold residue from ores of gold by treating the ores by roasting and fusing, and subjecting the roast to the action of acids.

52834—February 27, 1866. J. H. Elward and J. L. Hayes. *Improved process for separating gold and silver from ores.*

The process of oxidizing sulphurets containing the precious metals and converting them into sulphates by the use of solutions of nitrates.

56765—July 31, 1866. E. Lamm. *Improved method of preparing gold for dentists.*

The use of saccharine substances to precipitate gold from its solutions, thereby forming a mass of crystal shreds extremely useful and convenient for dental and other purposes.

148556—March 10, 1874. J. Douglas, Jr. *Improvement in extracting silver from its ores.*

The process of utilizing the waste liquors of the ordinary ore-chloridizing process, by allowing the insoluble matters contained in said liquors to precipitate, and then evaporating the clear supernatant liquid to obtain the soluble chlorides, which are reapplied in treating fresh ore.

207695—September 3, 1878. J. Tunbridge. *Improvement in separating metals from waste solutions.*

The process of separating precious metals from watery solutions, in which said metals are suspended by passing the watery solutions or suds through a bath of oil or hydrocarbon liquid.

219961—September 23, 1879. F. M. Lyte. *Improvement in extracting metals from ores.*

In the treatment of ores containing lead, zinc, silver, and copper, the method of securing the neutralization of the solutions of soluble bases, economizing acid, and carrying over the least possible quantity of silver and lead, which consists in treating the raw ores with an acid solution partially saturated by previous attack on the ores, and treating the partially exhausted ore by raw acid before the latter is admitted to the raw ore, the said steps being conducted in a continuous, alternate, and methodical manner.

227963—May 25, 1880. W. M. Davis. *Depositing gold from its solutions.*

The process of obtaining gold from its solution by bringing said solution in contact with carbon, and thereby depositing the gold upon it, and of subsequently obtaining the gold from the carbon by calcination or other equivalent means.

287737—October 30, 1883. C. A. Stetefeldt. *Process of treating sulphides.*

The process of treating sulphides, such as those obtained from the lixiviation process of silver ores, said process consisting in first exposing said sulphides to the action of dilute sulphuric acid in the presence of nitrate of soda, then converting the nitric oxide which escapes into nitrous acid and nitric acid, and finally carrying on the process by means of a mixture of nitrous acid and nitric acid with dilute sulphuric acid.

288838—November 20, 1883. J. Miller. *Process of recovering metallic particles from water.*

The method of recovering metals in suspension in liquid, consisting, essentially, in forcing such liquid through a filtering medium having a capacity of expansion, and resisted by a rigid inclosing vessel or medium, and then burning the filling material or otherwise separating the metal therefrom.

290258—December 18, 1883. J. Miller. *Apparatus for collecting and saving metallic particles.*

An apparatus for recovering metals or metallic compounds in liquids, consisting of a rigid tank, perforated on one side, in combination with an entrance pipe, provided with a trap and a pressure device.

290458—December 18, 1883. J. Miller. *Method of recovering metals.*

The improved method for recovering metallic particles, slimes, and similar material containing metal from liquids, consisting, essentially, in conducting the liquid and metal bearing material to a settling tank, allowing the gangue to fall to the bottom, drawing off the liquid, and forcing it under hydrostatic pressure through a filter press, and removing and drying the filtrate.

292605—January 29, 1884. C. P. Williams. *Art of extracting gold by means of alkaline sulphides.*

In the art of extracting gold from ores and artificial gold bearing products by means of alkaline sulphides the process, which consists in mixing the gold bearing material with carbon and an alkaline sulphate (or the equivalents of such carbon and alkaline sulphate), calcining said mixture in a nonoxidizing atmosphere at a temperature below the point of fusion of the charge, cooling the mass out of contact with the air, and leaching the cooled mass with water to dissolve out the soluble sulphides, and recovering the gold therefrom by precipitation

377809—February 14, 1888. T. Kiddie. *Process of separating precious metals and impurities from solutions of copper, salts, ores, mattes, etc., in acids.*

The process of removing precious metals and impurities from copper mattes, ores, bullion, etc., consisting in dissolving the same after desulphurization and calcination in sulphuric acid, in quantities sufficient to form a neutral solution, and in adding iron hydrates to the neutral solution, whereby the impurities are precipitated and settle with the precious metals not dissolved by the sulphuric acid, leaving a comparatively pure solution of iron and copper salts.

381809—April 24, 1888. R. Oxland and C. Oxland. *Treatment of ores and materials containing sulphur for the extraction of metals and other constituents.*

The method of treating raw or unburned sulphuret ores of copper and iron to render the copper soluble in water, while leaving the iron for the most part insoluble and rendering the sulphur in the ore available for the manufacture of sulphuric acid, consisting in mixing the finely pulverized ore to a semifluid consistency with sulphuric acid and solution of persulphate of iron, heating the mixture to a temperature such as to evolve sulphurous-acid vapor, and collecting and condensing such acid vapor.

387688—August 14, 1888. A. H. Low. *Extraction of zinc from ores.*

The process of extracting zinc from ores containing precious metals, consisting in leaching the ore with an aqueous solution of sulphurous-acid gas to dissolve out the zinc, and then boiling the leached liquor to expel the sulphurous-acid gas and cause a precipitation of the zinc.

403615—May 21, 1889. E. H. Russell. *Process of leaching ores with hyposulphite solutions.*

The process of extracting metal from ores and metallurgical products, which consists in introducing into the ore or product carbonate of soda, then treating the mass with a solution of sulphate of copper, and then treating it with a hyposulphite solution.

413808—October 29, 1889. J. S. MacArthur. *Process of leaching ores.*

The process of treating ores containing oxides or carbonates of earth metals, consisting in first subjecting such ores to the action of a proportionate quantity of a solution of a ferrous salt or a bisulphate of an alkali to combine with the oxides or carbonates of earth metals, and then treating the ores with an acid or salt to obtain the contained metals.

421031—February 11, 1890. R. Pearce. *Process of extracting silver from copper ores, mattes, and other copper products.*

The process of separating silver from ores or mattes containing base metals, which consists in mixing with the finely pulverized ore or mattes a quantity of sulphate of sodium or potassium equal to 2 per cent, then roasting the mixture, and finally leaching out by hot water to obtain the sulphate of silver.

440143—November 11, 1890. E. Dohe. *Process of separating gold and platinum from other metals in solution.*

The process of separating from an acid solution of gold, platinum, copper, and tin the metallic constituents of said solution, which process consists in first subjecting the entire solution in the presence of ether to agitation until the ether becomes yellow, in then decanting the remaining solution from the yellow ether, in then subjecting said remaining solution to agitation in the presence of essence of lavender until the essential oil becomes brown, and in then decanting from the brown essential oil the remaining solution and adding thereto ammonia.

442016—December 2, 1890. C. L. Coffin. *Process of treating ore containing lead, silver, and zinc.*

The process of treating ore containing lead, silver, and zinc to remove the zinc preparatory to smelting, consisting in first roasting the ore, then leaching the ore, filtering the leach fluid through carbon, then subjecting the leach fluid successively to the action of metallic lead and of metallic zinc, and finally precipitating the zinc held in solution in the leaching fluid.

444997—January 20, 1891. W. West. *Process of treating zinc ores.*

The process of eliminating zinc from complex ores, which consists in roasting the ore to form sulphurous-acid gas and oxidize the zinc, then cooling this gas to a temperature of 180° F. or below, and passing the same in gaseous form in conjunction with steam and without oxidation into sulphuric acid through a previously roasted charge to form soluble sulphite of zinc, and then immediately leaching out and separating the zinc sulphite with water at a temperature below 180° F.

449814—April 7, 1891. S. W. Cragg. *Lixiviation process of and apparatus for the extraction of gold or silver.*

The process of restoring the oxygen in a hyposulphite solution in the lixiviation process, which consists in passing a current of air through the ore pulp while the said solution is in contact therewith, and a leaching vat, a grating at the top thereof through which ore pulp and water are introduced to the interior of the vat, and a system of crossed separated bars within the vat through which the ore pulp and water pass, combined with an endless-apron filter on which the ore pulp and water fall from the said crossed bars, a trough beneath the filter to receive the water, and a lixiviation vat into which the apron filter discharges the ore pulp.

471616—March 29, 1892. J. Leede. *Process of treating refractory ores.*

The continuous process of treating refractory auriferous and argentiferous ores, which consists in subjecting the ore to the continuous action of an oxidizing blowpipe flame in direct contact with the ore at a moderate heat, intermittently subjecting the heated ore to the action of water, agitating the ore, and then repeating the operation at a higher heat, and finally subjecting it to an oxidizing roast without chills, whereby the volatile elements are driven off, the oxidizable elements or compounds are oxidized, and the precious metals are left free and in suitable condition for amalgamation or chlorination.

473189.—April 19, 1892. P. C. Choate. *Method of producing metallic zinc.*

The process of producing metallic zinc from its ores, which consists in separating the zinc and the equally volatile and more volatile constituents from the less volatile constituents of the ore by the use of heat and a reducing agent, then volatilizing and oxidizing the reduced metal, thereby obtaining a condensed oxidized fume, subjecting this fume to a moderate heat in order to expel its soluble constituents more volatile than zinc, treating the remaining product with dilute sulphuric acid as a solvent, and finally subjecting the resulting solution to the action of an electric current to precipitate the zinc.

481499—August 23, 1892. G. T. Lewis and C. V. Petraeus. *Process of treating sulphide ores of zinc and lead.*

The process of recovering lead and zinc from sulphureted lead and zinc-lead ore, which consists in roasting the ore, then smelting the roasted mass and exposing the fumes or volatile matter produced by said smelting to the action of the gases which are volatilized in the roasting of said ore, together with water, and then separating the zinc solution from the insoluble lead compound and recovering the zinc and lead.

483924—October 4, 1892. T. S. Hunt and J. Douglas. *Process of separating copper from cupriferous nickel ores.*

The method of separating the copper from a solution containing copper oxide and oxides of iron and nickel to produce nickeliferous iron, which consists in first adding common salt to the said solution, then passing a stream of sulphurous acid gas through the said solution, then precipitating the last traces of the copper in the form of metallic copper, and subsequently crystallizing out the nickel and iron and calcining and smelting the product to obtain nickeliferous iron.

483977—October 4, 1892. C. Whitehead. *Process of treating mixtures containing sulphides of precious metals and copper.*

The process of treating a mixture containing sulphides of the precious metals and of copper, which consists in mixing the sulphides with solution of a salt of silver, whereby a soluble salt of copper is formed and sulphide of silver is precipitated, separating the solution containing the copper from the residue containing the precious metals, roasting this residue to reduce the precious metals to the metallic state, treating the reduced metals with hot sulphuric acid to dissolve the silver, separating the silver solution from the residue, and melting the final residue.

490068—January 17, 1893. F. P. Dewey. *Process of treating mixtures containing sulphides.*

The process of treating mixtures containing sulphides of silver and copper, which consists in heating the sulphides with strong sulphuric acid to convert the sulphides into sulphates and dissolve the sulphate of silver, adding water, to bring the sulphate of copper also into solution, drawing off the resultant solution, precipitating the silver therefrom by metallic copper, and recovering the sulphate of copper from the remaining solution.

490156—January 17, 1893. A French. *Process of obtaining gold, silver, and copper from ores.*

In processes for obtaining gold, silver, and copper from ores, the treatment of the ores by pulverizing, mixing therewith small percentages of niter cake or bisulphate of soda and common salt, furnacing at a red heat, and then leaching.

497473—May 16, 1893. W. R. Ingalls and F. Wyatt. *Process of treating complex or sulphide ores.*

The process of treating complex sulphide ores, which consists, first, in subjecting the ore to a sulphatizing roasting; second, lixiviating the roasted ore with water and sulphuric acid and removing the iron therefrom if necessary; third, precipitating the zinc from said solution in the form of carbonate or carbonate and hydroxide by the use of sodium carbonate and subsequently converting the same into zinc oxide; fourth, evaporating the sodium sulphate obtained from the zinc sulphate solution and heating the same with sodium chloride and coal to convert it into sodium sulphide; fifth, converting the sodium sulphide into bicarbonate of soda by dissolving the same in water and treating the solution with carbonic acid gas; and lastly, converting the bicarbonate of soda into sodium carbonate by heating the same to drive off the hydrogen and carbonic acid gas.

509658—November 28, 1893. E. Waller and C. A. Sniffin. *Method of concentrating ores.*

The method of concentrating argentiferous lead carbonate ores, which consists in dissolving out lead from the ore with the aid of acetic acid, real or combined, and water, out of contact with the air whereby the lead and carbonic acid eliminated from the ore are rendered capable of utilization in the arts, and the undissolved silver is concentrated in the residue.

509634—November 28, 1893. D. K. Tuttle and C. Whitehead. *Process of treating precious metal bearing slimes.*

The process of treating precious metal bearing slimes, which consists in subjecting the slimes to the action of dilute acids to dissolve the metals and oxides soluble therein and to the action of a solution of a salt of silver to remove metals more electro-positive than silver that are present in the metallic state.

509635—November 28, 1893. D. K. Tuttle and C. Whitehead. *Process of refining slimes from the electrolytic refining of copper.*

The process of treating slimes from the electrolytic process of refining copper, which consists in removing arsenic, antimony, tellurium, bismuth, and other impurities present as oxides by treating the slimes with dilute acid and heating the purified slimes with strong hydric sulphate.

513490—January 30, 1894. S. H. Emmens. *Process of treating zinc-lead-sulphide ores.*

The process of treating zinc-lead-sulphide ores carrying gold or silver or gold and silver, which said process consists in, first, finely comminuting the ore; secondly, roasting the same in an oxidizing atmosphere; thirdly, leaching such roasted ore with water containing ferrous sulphate; fourthly, leaching such once leached ore with an aqueous solution of ferrous and ferric sulphates; fifthly, leaching such twice leached ore with water containing ferrous sulphate; and sixthly, removing iron from the zinc sulphate solution obtained by the first and second of the said leachings by mixing such solutions together and heating them.

516016—March 6, 1894. W. R. Ingalls and F. Wyatt. *Treatment of ores of zinc.*

The process of treating ores of zinc, which consists, first, in subjecting the ore to an oxidizing roasting, second, lixiviating the roasted ore with water and sulphuric acid; third, separating one-fourth of the zinc-sulphate solution thereby formed from the rest and precipitating the zinc from said separated portion by means of a sulphide of an alkaline base; fourth, evaporating the remainder of the zinc-sulphate solution to dryness and mixing the precipitated sulphide therewith; and lastly, heating the mixture in a suitable furnace whereby sulphurous anhydride gas is evolved.

518860—April 24, 1894. L. Klöz. *Process of extracting zinc from ores.*

The process of treating zinc ores, which consists, first, in the preparation of a concentrated solution of sulphurous acid; second, in leaching the ores or furnace products with this solution to form a concentrated zinc sulphite solution free from sulphates; and third, scattering this solution by steam to dispel the sulphurous acid and precipitate the zinc sulphite.

527473—October 16, 1894. P. Argall. *Cyanide and chlorination process for treating gold or silver bearing ores.*

In the process of preparing gold and silver bearing ores for the extraction of the precious metals, the improvement consisting in separating the slime from the granulated ore, preventing the forming of acid in the slime by mixing lime therewith, and then forming the mixture into lumps for burning.

541374—June 18, 1895. E. B. Mierisch. *Process of extracting gold and silver from their ores.*

The process of extracting gold and silver from oxidated or roasted ores, which consists in mixing the ground ores with sodium hydrate, mixed with a corresponding quantity of calcium hydrate, then subjecting the mixture to the action of chlorine, whereby the ores are acted upon by chlorates, and hydrochlorites formed "in statu nascendi," and then leaching the lye with a concentrated sodium-chloride solution, the deterioration of which is prevented by the addition of the calcium hydrate to the sodium hydrate.

541447—June 18, 1895. H. F. Watts and A. Conn. *Process of reducing zinc slimes.*

The process of treating zinc slimes containing the precious metals, which consists in first treating the same with dilute sulphuric acid for the purpose of removing metallic zinc, washing the residue to remove the soluble salts and the remaining acid, and boiling the residue thus formed with concentrated sulphuric acid to dissolve the cyanide of zinc and the other salts thereof which are insoluble in the dilute acid.

541659—June 25, 1895. J. J. Crooke. *Process of and apparatus for extracting silver from its ores.*

The process of extracting silver from its ores, which consists in roasting the ores with chloride of sodium, treating the roasted mass with a hot aqueous solution containing chloride of sodium, nitrate of copper, and sulphuric acid, and recovering the silver from the solution.

544490—August 13, 1895. H. Brewer. *Process of utilizing waste lye.*

The process of treatingànciferous or cupriferous lyes resulting from the lixiviation of chlorinated roasted ores, which consists in chemically extracting the metals in the lye, except the zinc, removing the sodium chloride by concentration of the lye, extracting the zinc and chlorine from the remaining lye electrolytically, and effecting the chemical extraction in such manner that the final lye will consist essentially of a solution of calcium chloride.

544612—August 13, 1895. A. Crossley. *Process of manufacturing zinc.*

The process for the manufacture of zinc oxide, which consists in adding sulphuric acid to the metallic ores or compounds, heating the mixture and converting the lead present to an insoluble salt, and depositing any silver or gold present, then diluting with water and converting the other metals present to soluble salts, filtering off the clear liquor, then treating the clear acid liquor filtered off with an alkaline sulphide, precipitating the copper as copper sulphide, then filtering the liquor from the precipitate, treating with an alkali until neutral, passing chlorine into it until all manganese and iron present form manganic and ferric oxides, which are thrown down by a slight excess of alkali, adding an excess of alkali to bring the zinc oxide into solution, and then precipitating the zinc oxide, and filtering off the liquor therefrom.

547587—October 8, 1895. C. V. Petraeus. *Method of extracting zinc from complex ores.*

The method of separating zinc from complex ores where it is found as a sulphate or sulphite, which consists in crushing the ore, roasting it, dissolving out the soluble zinc salts in water, adding a solution of sulphuric acid to dissolve out any zinc oxide, introducing live steam to the mixture of ore and solvents to thoroughly mix and heat them, separating the solution of sulphate of zinc from the insoluble parts of the ore, adding chloride of calcium to the solution to convert the zinc into a chloride, separating the solution of zinc chloride from the precipitated calcium sulphate and finally adding quicklime to the solution of zinc chloride to precipitate the zinc as zinc oxide.

556696—March 17, 1896. G. O. PEARCE. *Process of extracting gold from solutions.*

The process of recovering gold and platinum metals from aqueous solutions of these metals, which consists in passing said solutions through a mass of vegetable carbon having associated with it sulphate of iron, oxalic acid, and tartaric acid.

559614—May 5, 1896. G. A. SCHROTER. *Extraction of precious metals.*

The process of extracting precious metals, particularly silver, from ores and metallurgical products, which consists in leaching the crushed and chloridized ore with a concentrated solution of brine to which has been added a small per cent (one-half to 4 per cent approximately) of a soluble salt of copper.

561544—June 9, 1896. F. P. DEWEY. *Process of treating sulphides.*

The process of treating mixtures containing sulphides of silver and copper, which consists in heating the mixture with strong sulphuric acid, adding water, adding more mixed sulphides, separating the solution of sulphate of copper from the residue containing the sulphide of silver, and heating the sulphide of silver with strong sulphuric acid to convert it into sulphate.

561571—June 9, 1896. F. P. DEWEY. *Process of treating mixtures containing sulphides.*

The process of treating mixtures containing sulphides of silver and copper, which consists in heating them to a temperature at which the sulphur is oxidized, in an excess of sulphuric acid sufficient to convert the sulphides of silver and copper into sulphates, and bring the sulphate of silver into solution outside of the mass of material treated, thereby oxidizing the sulphur, converting the sulphides into sulphates, and bringing the sulphate of silver into solution in the acid outside of the mass of material acted upon.

571369—November 17, 1896. B. HUNT. *Process of refining gold and silver bullion.*

The process of refining bullion slimes by first roasting the slimes to decompose all cyanogen compounds and carbonaceous matters and then treating the roasted slimes with nitric acid.

586150—July 13, 1897. H. BREWER. *Process of treating zinc sulphide ores.*

In a process of treating zinciferous sulphate lyes resulting from the lixiviation of chlorinated roasted zinc sulphide ores, adding sodium chloride to such lye to saturation or in excess, and crystallizing out the resulting sodium sulphate (Glauber salt) by refrigeration as a by-product.

587128—July 27, 1897. E. F. TURNER. *Process of treating argentiferous sulphide ores.*

In a process for the extraction of the metal of compound sulphide ores, disintegrating and decomposing the latter by the combined action of aqueous and gaseous hydrochloric acid, neutralizing the acid gases evolved whereby sulphureted hydrogen is obtained, heating the disintegrated ore by means of such sulphureted hydrogen, collecting the sulphur dioxide resulting from the combustion, bringing this gas into contact with sodium chloride in presence of heat, whereby hydrochloric acid gas and sodium sulphate are obtained, and utilizing the former in the process of disintegration.

588476—August 17, 1897. H. A. RHODES. *Process of separating gold and silver or other precious metals from their ores.*

In chemical processes for the separation of gold or other precious metals from their ores, slimes, or compounds, the method of preparing the ores by adding thereto a self hardening, binding material and forming a porous and rigid mass of the compound whereby the precious metals contained therein are freely acted upon by the solvent.

589959—September 14, 1897. J. J. CROOKE. *Process of treating copper sulphides.*

The process of recovering silver or gold and extracting copper in a metallic condition from copper sulphides associated with iron sulphides, which consists in roasting the pulverized sulphides with sodium chloride at a low heat, leaching the roasted mass with a solution whereby the iron sulphides are largely converted into oxides and the silver and gold are dissolved by and removed with the solution, recovering the silver and gold from the solution, roasting the residuum or tailings, fluxing the roasted tailings with silica and pulverized carbon, gradually melting the roasted and fluxed charge to convert the oxide of iron into metallic iron and desulphurize the copper sulphides to liberate metallic copper and form an iron silicate slag, removing the slag from the melted copper, adding a small per centum of silica to convert any remaining iron oxide or metallic iron into an iron silicate slag, and removing this slag from the copper.

602295—April 12, 1898. E. A. ASHCROFT. *Treating solutions or ores containing zinc for recovering zinc as oxides.*

The process of treating neutral zinc solutions for the production of zinc oxide, which consists in first converting the neutral zinc salt into basic zinc salt by the addition of zinc oxide and then intimately mixing with said basic zinc salt, carbon in approximately the proportion of one-twentieth of the weight of the zinc to be recovered, and heating the mixture to a temperature approximating the melting point of aluminum.

623154—April 18, 1899. H. HOWARD. *Extraction of zinc and copper from ores.*

The process of extracting zinc and copper from ore or residue, which consists in treating the same with aqua ammonia and ammonium sulphate; separating the copper from the resulting solution; adding sufficient soda to combine with all of the sulphuric oxide present and form sulphate of soda, and evaporating the solution to drive off ammonia, the latter being collected in water; and treating the residue with water to dissolve out the sulphate of soda, the zinc oxide remaining.

624000—May 2, 1899. J. DUBIE. *Method of reducing metallic sulphides.*

In the process of causing the solution of metallic sulphides containing lead, subjecting the sulphide ore to a solution of sulphuric acid and a nitrate of an alkali metal at a temperature of about 212° Fahrenheit, washing and filtering the lead sulphate obtained therefrom, dissolving the said sulphate, precipitating by carbon dioxide, washing and drying the precipitated hydrated carbonate of lead, and recovering the sulphur.

625453—May 23, 1899. M. BODY. *Process of treating sulphureted ores.*

In the process of treating sulphureted ores of a complex nature, comminuting and melting the ore in presence of an alkaline salt and carbon, whereby alkaline polysulphides soluble in water are formed, plunging the melted mass into water, whereby a magnetic precipitate is formed and the polysulphides dissolved in the water, separating the solution from the precipitate, subjecting the same to the action of air and sulphurous-acid gas forced thereinto, whereby monosulphides of iron, together with the precious metals, are precipitated, maintaining the alkalinity of the solution during the operation of precipitation by addition of an alkaline substance, as lime, separating the solution from the monosulphide-of-iron precipitate, extracting from the latter the copper and then the precious metal, and separating the arsenic and antimony from the solution by precipitation.

627024—June 13, 1899. R. Threlfall. *Method of treating flue dust and fume obtained from sulphide ores.*

In the treatment of flue dust and fume from sulphide ores, the separation of the zinc from the lead constituents by leaching out the former by means of a solution of alkali metal hydrogen sulphate.

630951—August 15, 1899. L. Vanino. *Wet process of extracting silver from its haloid salts.*

The wet process of extracting silver from its insoluble haloid salts, which consists in mixing said haloid salts with a watering solution of alkaline agents, and adding formic aldehyde in the cold.

635056—October 17, 1899. D. O'Keefe. *Process of treating ore.*

The process of treating ore, consisting of roasting the same while being agitated, for the purpose of mechanical disintegration, subjecting the ore to hydrogen gas under pressure, afterwards to chlorine gas, and then leaching the same with hot salt water.

635695—October 24, 1899. C. Martin. *Process of chemically preparing and treating rebellious ores.*

The process of effecting the separation of gold, silver, tin, lead, and platinum, in pulverized rebellious ore containing arsenic and antimony, which consists in effecting sulphurization and disintegration of the said ore, producing a sulphide solution of the metals in said ore, and thereupon precipitating the dissolved metallic compounds other than arsenic and antimony by mingling the same with an oxide of an alkali earth metal.

635792—October 31, 1899. F. W. Martino and F. Stubbs. *Process of treating ores containing precious metals.*

The treatment of ores or tailings containing the precious metals by finely dividing the ore, mixing it with calcium carbide, and moistening the mixture with water.

644770—March 6, 1900. R. W. Kennedy. *Solvent for leaching ores.*

A solvent for leaching ores, comprising sodium thiosulphate, ammonium carbonate, copper sulphate, and potassium cyanide in water.

647989—April 24, 1900. T. Ryan, Jr., and N. Hughes. *Process of extracting zinc from substances containing same.*

The process of extracting zinc from substances containing the same, consisting in subjecting the raw material to the action of a solution of a caustic alkali, precipitating any lead present by galvanic action, securing the removal of organic matters and iron, manganese, and silicon by the addition of caustic lime and bleaching powder, and finally precipitating the dissolved zinc in the form of zinc oxide or zinc hydroxide by decaustifying the solution by the addition of an acid.

648354—April 24, 1900. C. G. Collins. *Process of extracting metals from their ores.*

The process of extracting metals from their ores, consisting in dissolving out or extracting the metal from the powdered ore by means of a solution of ammonium salt in the presence of an alkali base capable of decomposing the ammonium salt, and then precipitating the metal by the addition of a solution of an alkali metal.

652072—June 19, 1900. G. de Bechi. *Treatment of ore.*

The method of treating complex ores, consisting in subjecting the ore to a chloridizing roasting, condensing the vapors and gases evolved, treating the roasted ore and the acidulated water containing the condensed vapors and gases with calcium chloride to precipitate soluble sulphates and sulphuric acid as insoluble calcium sulphate, then lixiviating the ore with the acidulated water to obtain a solution of zinc and copper salts and fractionally precipitating zinc and copper from the said solution as hydrated oxides by successive additions of lime.

652849—July 3, 1900. S. H. Johnson and H. L. Sulman. *Process of extracting metals from ores or slimes.*

The method of treating pressed slime cakes containing residual water, which consists in displacing the residual water with an equal volume of a solvent solution, mixing the cakes with a further quantity of solvent solution, removing the metal bearing solvent solution by pressure, displacing the remaining portion of such metal bearing solution with water and extracting the metal from said metal bearing solution, whereby all the operations may be performed with an approximately constant volume of the solvent solution.

653413—July 10, 1900. E. Fink. *Process of extracting copper or other metals from tailings or ores of such metals.*

The process of extracting copper and other metals from tailings or ores of such metals, which consists in subjecting the tailings or ore to the action of a solution containing sulphuric acid and to the action of an oxide or oxides of nitrogen in the presence of air or oxygen under pressure, whereby the metal is oxidized and dissolved and the oxide or oxides of nitrogen are converted alternately into a lower and a higher oxide or oxides, and finally separating the solution from the earthy matter of the tailings or ore and separating the metal from the solution.

653894—July 31, 1900. G. Rigg. *Process of obtaining oxide and carbonate of zinc from materials containing zinc.*

The process of producing oxide of zinc and carbonate of zinc from zinciferous material, which consists in leaching the zinciferous material with a solution of ammonia and carbon dioxide wherein the carbon dioxide is in such proportion to the ammonia as to impart to the latter an approximately maximum zinc dissolving capacity.

656497—August 21, 1900. G. de Bechi. *Process of treating zinc bearing complex ores for recovery of zinc or other metals therefrom.*

The method of treating complex zinc ores for the recovery therefrom of copper, zinc, and lead, consisting in separately roasting the ore and an alkali chloride in the presence of air and steam, conveying the sulphurous and sulphuric vapors thus derived from the ore over and in contact with the said chloride during the roasting to obtain hydrochloric acid fumes, condensing the acid fumes, lixiviating the roasted ore with the acid liquor thus obtained to produce a solution of metallic chlorides, and successively precipitating the metals of the metallic chlorides as hydrates by successive additions of alkali.

656744—August 21, 1900. H. Hirsching. *Process of treating gold and silver ores.*

The process of treating copper ores, which consists in adding the comminuted ore gradually under agitation to an ammoniated solution, and then adding a diluting liquid to the mixture to obtain a highly concentrated copper solution.

657955—September 18, 1900. H. Petersen. *Process of enriching metallic sulphides.*

The process of enriching metallic sulphides, which are mixed with carbonates of the alkali-earth metals, consisting in dissolving out the carbonates with an aqueous solution of sulphurous acid.

659338—October 9, 1900. C. G. Collins. *Process of extracting zinc and copper from their ores.*

The process of treating ores of copper and zinc, which consists in immersing the comminuted ore in a solution containing sodium sulphate and bisulphate (niter cake), removing the depleted ore and extracting the metal therefrom by electrolytic action, adding more comminuted ore to the remaining solution, and repeating the operation.

659339—October 9, 1900. C. G. Collins. *Process of extracting copper and zinc from their ores.*

The process of treating ores of copper and zinc containing other metals soluble in any excess of solution which may be employed above that required to dissolve the copper and zinc contained therein, which consists in introducing the comminuted ore into a solution of sodium sulphate containing hydrochloric and sulphuric acid (salt-cake solution) not exceeding 5° Baumé, and subsequently recovering these metals from the solution.

659670—October 16, 1900. C. J. Head and R. C. Wild. *Method of treating telluride ores.*

A process for the extraction of tellurium from telluride auriferous ores and the preparation thereby of said ores for the better extraction of the precious metal therefrom, consisting of a lixiviation and digestion of the said ores in a solution containing about 5 per cent of caustic potash or soda for a lengthened period of two to six hours, the withdrawal of the solution after such digestion from the said ores, and the recovery of the tellurium from the solution.

660013—October 16, 1900. C. J. Head and R. C. Wild. *Method of treating telluride ores.*

A process for the extraction of tellurium from telluride auriferous ores and the preparation thereby of said ores for the better extraction of the precious metal therefrom, consisting of a lixiviation and digestion of the said ores in a solution containing about 5 per cent of carbonate of sodium or potassium for a lengthened period of two to six hours, the withdrawal of the filtrate, and the recovery of the tellurium from the solution.

668750—December 11, 1900. C. Hoeffner. *Process of producing solutions of zinc chloride.*

The process, which consists in reacting upon an oxide or insoluble salt of zinc in presence of water with sulphurous acid to form soluble zinc bisulphite, converting the bisulphite into a monosulphite by suitable reagents, mixing therewith its equivalent of sodium or potassium chloride and exposing the mixture to heat and air in the presence of a contact substance, such as oxide of iron, in order to convert the monosulphite into a sulphate, separating the zinc chloride from the solution and mixing therewith a sufficient quantity of an aqueous solution of sodium chloride to dissolve the zinc chloride and leave the alkali-metal sulphate practically undissolved.

678210—July 9, 1901. J. W. Worsey. *Process of treating complex ores.*

Process for the treatment of complex sulphide ores, comprising, first, the reduction of the combined sulphur below 15 per cent by calcination; secondly, finely powdering the calcined ore; thirdly, adding sodium nitrate; fourthly, boiling the mixed ore and nitrate in dilute sulphuric acid; fifthly, roasting the semisolid mass in a closed furnace; sixthly, dissolving out zinc copper and other soluble salts from the said mass by weak sodium-sulphate solution; seventhly, removing any copper from the solution; eighthly, precipitating the zinc and other metals from the solution; and, ninthly, separating the zinc.

679215—July 23, 1901. H. C. Bull. *Method of extracting gold from sea water.*

The method of extracting gold from sea water, which consists in mixing with a quantity of sea water a proportion of milk of lime to react upon the iodide of gold contained in the sea water to form iodide of calcium and to liberate the gold, then allowing the sludge formed by the reaction to settle, then drawing off the water and then collecting the sludge and treating it to extract the metallic gold therefrom.

683325—September 24, 1901. H. J. Phillips. *Extraction of precious metals from their ores.*

The method of extracting precious metals from refractory sulphide or telluride ores without roasting, which consists in subjecting the ore without roasting and in the form of a powder, under heat and pressure, to the action of alkaline polysulphides in solution of such weakness that same will have a selective action, namely, will dissolve the elements which are combined with the gold, and for which the polysulphides have a greater affinity than for gold, without dissolving the gold itself, which latter is thus dissociated and can then be recovered by any known suitable process for recovering free gold.

684578—October 15, 1901. C. W. Merrill. *Precipitant for recovering metals from solutions.*

The combination with a metal capable of precipitating other metals from cyanide solutions, if a gritty, inert, nonmetallic material, to increase the surface exposed per unit of weight of the precipitating metals.

689835—December 24, 1901. G. H. Waterbury. *Process of extracting copper from ores.*

The process of precipitating copper in solution, consisting in placing the solution in a tank or receptacle containing pieces of iron small enough to allow the solution to pass readily therethrough, and introducing hot air under pressure into the solution.

692008—January 28, 1902. O. Frölich, M. Huth, and A. Edelmann. *Separating process for ores.*

In the art of separating metals from ores containing iron among a plurality of metals existing therein in a combined form, the process, which consists in heating the ore to a temperature below the decomposition temperature of the sulphate of the metal to be sulphated, but above the decomposing temperature of the sulphate of any other metal existing in the ore, and then passing over it a gas mixture containing sulphur dioxide and oxygen.

693148—February 11, 1902. E. B. Parnell. *Process of treating ores.*

In the treatment of refractory ores, the process, which consists in subjecting them to the action of chromic acid and then roasting them.

695366—March 11, 1902. M. M. Haff. *Separation of the constituents of complex sulphide ores.*

The process, which consists in heating mixed sulphides of zinc and lead with sulphate of an alkali metal, treating the resultant mass with a dissolving agent to dissolve the zinc sulphate and alkali-metal sulphate, while leaving the lead sulphate undissolved, and adding barium hydrate to the mixed solution of zinc sulphate and alkali-metal sulphate to precipitate zinc hydrate and barium sulphate.

699326—May 6, 1902. T. A. Irvine. *Extraction of copper by the wet method.*

A process for the extraction of copper, consisting in the treatment of the ore within a mixed solution of chloride of sodium and sulphuric acid, in which solution there is an excess by weight of the chloride of sodium in respect to the sulphuric acid.

700311—May 20, 1902. F. Ellerhausen. *Treatment of complex and refractory ores.*

The process of treating complex and refractory ores containing lead, silver, and zinc, which consists in smelting the raw ores, churning the fumes and gases with water to condense and mix them with water, settling out the lead, silver, and part of the zinc compounds from the resulting liquor, as a sludge, separating and drying the sludge and fusing the sludge with caustic alkali, thereby precipitating the lead in metallic form.

702047—June 10, 1902. C. G. Collins. *Process of rendering metallic sulphides soluble.*

The process of rendering metallic sulphides soluble, consisting in drenching the crushed sulphide ore with aqueous ammonia, draining off the excess of aqueous ammonia, treating the ore thus moistened to an excess of oxygen, leaching the ore, and repeating the operation until the metal is all extracted from the pulp.

702153—June 10, 1902. J. P. van der Ploeg. *Treatment of ores and materials containing antimony.*

The method of extracting antimony from ores, materials, or residues containing it, consisting in finely pulverizing the material, mixing it with a suitable quantity of powdered quicklime, and then mixing with it an adequate quantity of sulphide of an alkali-earth metal and water, so as to form a solution of the lower and most soluble double sulphides as being the best electrolytes, without the use of artificial heat or application of pressure.

702244—June 10, 1902. A. J. Polmeteer. *Precipitant for treatment of copper water.*

The precipitant for copper water, containing in solution a sulphide and an excess of alkali.

702581—June 17, 1902. J. W. Neill and J. H. Burfeind. *Process of recovering metals from ores.*

The improvement in treating copper or other ores, consisting in agitating a charge of pulp containing the ore by gas from roasting furnaces charged with material suitable for producing sulphurous-acid gas, separating the resultant solution, precipitating the metal from the solution, thereby releasing gas and employing the sulphurous-acid gas released by the precipitating process to enrich the gas derived from the furnace and used in leaching a charge of ore.

704630—July 15, 1902. C. Hoepfner. *Process of extracting copper and nickel from sulphide compounds.*

The process, which consists in oxidizing roasting copper and nickel sulphide ores or mattes, leaching the sulphate of copper formed, converting this into cupric chloride and then into cuprous chloride, dissolving the nickel salts in the residue by said cuprous chloride, precipitating cuprous chloride from the solutions formed and returning the resulting solution containing some cuprous chloride into the cycle of operations.

704631—July 15, 1902. C. Hoepfner. *Process of extracting zinc or other metals from their ores.*

The process, which consists in reacting on a material containing an oxygen compound of metals insoluble in water and whose chlorides are soluble in a solution of alkali metal chloride, with sulphurous acid and an aqueous solution of alkali metal chloride, whereby a solution is formed containing a chloride of a metal.

706301—August 5, 1902. L. B. Darling. *Means for extracting precious metals from ores.*

In a gold extracting plant provided with a substantially flat treating floor of nonabsorbent material, a series of longitudinally extending channels formed therein, a transverse groove or end launder in direct communication with said channels, fixed screens or strainers covering the top of said channels and launder, side launders or ducts, and valved connections interposed between and uniting the said end and side launders.

707107—August 19, 1902. J. Herman. *Process of treating ores.*

The process, which consists in roasting sulphide of copper ore at a low heat to form sulphates of the copper and some of the iron present, and produce a large percentage of ferrous sulphate, leaching the roasted ore, precipitating the metallic copper, and adding salt to the leaching solution before or after the precipitation of the metallic copper, whereby the ferrous salts in the solution are converted to the chloride, and a solution having an excess of salt is produced, and the said solution is adapted to dissolve copper and silver out of carbonate and oxide ores.

707506—August 19, 1902. E. Ferraris. *Method of treating mixed sulphide ores.*

The process of decomposing mixed sulphide ores by means of concentrated sulphuric acid without the aid of extraneous heat.

709037—September 16, 1902. W. Pethybridge. *Treatment of telluride gold ores.*

In the decomposition of ores containing telluride of gold, the process of reducing the ore to a finely divided state and then exposing the ore to the action of a solution of ferric chloride alone to attack the tellurium.

715023—December 2, 1902. J. C. Clancy and L. W. Marsland. *Process of treating zinc sulphide ores.*

In extracting metals from zinciferous sulphide ores, roasting pulverized ores with the addition or admixture of lead sulphate obtained from a source external to the ore being treated in quantity proportional to the quantity of zinc the ore contains.

715771—December 16, 1902. F. Ellershausen and R. W. Western. *Treatment of zinc ores.*

The process for the treatment of zinc ores and other zinciferous matter, consisting in calcining where necessary, wetting with a dilute solution of ammonium sulphate, adding sulphuric acid, washing with ammonium sulphate, and precipitating with aqueous ammonia and heating the precipitate.

715804—December 16, 1902. H. E. Howard and G. Hadley. *Treatment of spent acid from galvanizing works.*

The treatment of spent acid from galvanizing works by adding zinc thereto, separating the solution from the precipitate, treating with bleaching powder to transform the ferrous salts into ferric salts, then adding alkali to precipitate the iron present as ferric hydrate, and subsequently more alkali for the precipitation of the zinc salts.

716842—December 23, 1902. F. W. Martino. *Treatment of ores containing precious metals.*

The process of separating gold from ores containing tellurium, selenium, sulphur, arsenic, antimony, tin, phosphorus, or the like, consisting in grinding the mixture, heating it with powdered barium sulpho carbide in a reducing (muffle) furnace, dissolving out the soluble sulphides thus formed, treating the solid residue with a gold solvent, and precipitating the gold therefrom by the employment of barium sulpho carbide.

717209—December 30, 1902. G. C. Stone. *Extraction of zinc and lead from sulphide ores.*

The method of separating zinc and lead from sulphide ores, which consists in smelting the sulphides, oxidizing the volatile constituents at their exit from the smelting furnace, cooling the resulting fumes and products of combustion to a temperature not exceeding 180° F., and passing them into contact with a solvent which will dissolve out one of the metals and not the other.

717565—January 6, 1903. A. von Gernet. *Process of extracting copper from its ores.*

The process of extracting copper from its ore, which consists in slowly passing the ore in the form of pulp through a current of sulphurous acid, passed in a direction opposite to that of the travel of the pulp.

717864—January 6, 1903. J. T. Jones. *Method of treating ores.*

The process of mixing with ore, to be treated, a leaching fluid, which consists in confining the mass of ore in a vessel with a body of leaching fluid of lesser specific gravity superimposed upon it, carrying portions of the ore upward in said vessel and releasing it above the body of leaching fluid, to precipitate it through said body and simultaneously convey portions of the leaching fluid below the surface of the mass of ore and releasing it, and permitting it to rise through the same.

718099—January 13, 1903. S. C. C. Currie. *Method of reducing ores.*

The step in the art of treating pulverized ores containing precious metals, which consists in subjecting the ore, in a closed vessel, to the action of hot air at a temperature which reduces some of the salts in the ore from an insoluble to a soluble condition in water, then washing away the soluble salts with water and then repeating the step with air at a higher temperature.

719132—January 27, 1903. W. Payne, J. H. Gillies, and A. Gosbolt. *Process of treating copper ores.*

The process of treating copper ores, consisting in first roasting to an oxide, next saturating the same with a solution of ferrous sulphate or sulphate and chloride, next roasting again and meanwhile adding a small percentage of iron sulphide or sulphur, according to the percentage of copper present, and finally leaching the hot ore.

719757—February 3, 1903. S. C. C. Currie. *Process of treating ores containing precious metals.*

The method of treating ore, which consists in heating the raw pulverized ore in contact with steam, and plunging the heated ore into an aqueous alkaline solution.

723787—March 24, 1903. S. Trivick. *Process of extracting metals from ores.*

A process for evolving nascent chlorine and effecting the chlorination of metallic substances in order that they may be extracted from a metalliferous mass by rendering them solvent, consisting in adding to the mass a mixture in definite proportions of two substances, one being dry chloride of lime and the other ferric sulphate, the proportions being such as to result in the formation of ferric hypochlorite and ferric chloride which will evolve nascent chlorine.

723949—March 31, 1903. G. D. Van Arsdale. *Process of separating copper from ores.*

The process of extracting copper from ores, or products containing copper, which consists in separating copper from cupric-sulphate solutions, with or without ferrous or other suitable sulphate, and of simultaneously producing free sulphuric acid, by adding to such solutions sulphur dioxide and heating with or without pressure, whereby copper or copper compounds are thrown down in the solid form to be subsequently treated, and free sulphuric acid is formed, and of adding the acid liquors thus obtained, after separation from the copper precipitate, to copper ores, whereby the copper contained in them is dissolved and the original solution regenerated and the process repeated and thus made continuous.

724414—March 31, 1903. G. H. Waterbury. *Copper leaching process.*

The copper leaching process, consisting in placing the suitably pulverized ore in a leaching tank, adding water, acid, common salt, and oxide of manganese in suitable quantities, heating the mass by the introduction of steam to a suitable temperature, and finally subjecting the pulp to agitation during a suitable period.

725457—April 14, 1903. T. B. Joseph. *Gold extraction process.*

The process of extracting precious metals from ore containing the same, when in a suitable condition, which consists in subjecting the said ore to a leaching action of a solution of water, cyanide of potassium, hydrate of calcium, carbon dioxide, and bromine, and subsequently precipitating the precious metals from the solution.

725548—April 14, 1903. H. R. Ellis. *Process of extracting copper from carbonate and oxide ores.*

The process of extracting and recovering copper from its carbonate or oxide ores or from material carrying carbonates or oxides of copper, which consists in subjecting the ore or other material in a crushed or powdered state to the action of a carbonate of soda or its described equivalents until the copper is dissolved and subsequently subjecting the charged solution to electrolytic action.

726802—April 28, 1903. B. T. Nichols. *Ore treating process.*

The process for treating ore preparatory to leaching, consisting first in mixing the suitably pulverized ore with lime; second, applying water to the mixture and introducing steam whereby the pulp is agitated and kept at a suitable temperature until certain impurities which retard leaching are freed; third, washing the pulp by the introduction of water and continued agitation; fourth, draining off the water as far as practicable; and, finally, drying the ore.

729760—June 2, 1903. G. V. Gusman. *Process of reducing and separating silver.*

The process of extracting and separating silver from its ores, which consists in subjecting roasted ores to the action of a preprovided aqueous solution of cupric chloride and cuprous chloride, passing the resulting solution through granulated metal, and removing and collecting the metallic silver from said metal.

729819—June 2, 1903. J. F. Webb. *Apparatus for use in extracting metals from ores.*

A tank for use in extracting metals by chemical process from their ores, having a filter bottom and means for discharging air within the tank and downwardly upon the said bottom, whereby the said bottom is kept free from clogging and air is supplied to agitate the mass within the tank and supply oxygen thereto.

734683—July 28, 1903. J. F. Duke. *Process of obtaining gold from sea water.*

The process of obtaining gold from sea water containing the same, which consists in precipitating the gold by carbonate of calcium.

735098—August 4, 1903. C. Hoepfner. *Process of obtaining lead or other metals from ores or mattes.*

The process, which consists in leaching compounds containing lead and iron with a solution of cupric chloride containing a solvent of the chlorides of said metals, supplying oxygen to produce oxychloride of copper whereby the iron is precipitated, and precipitating the lead as a sulphite by means of a sulphite of zinc.

735512—August 4, 1903. H. Hirsching. *Treatment of ores containing gold, silver, copper, nickel, and zinc.*

The process for extracting gold, silver, copper, nickel, and zinc from substances containing the same, which consists in subjecting said substances to the action of an acid, washing with water the substance thus treated, thereby forming solutions containing compounds of gold and base metals, and then subjecting said solutions to the action of ammonia for the purpose of precipitating the gold and recovering the base metals from the solution separately, and also the ammonia.

739011—September 15, 1903. F. Laist. *Process of treating ores.*

The method of generating hydrogen sulphide and precipitating copper, which consists in subjecting an alkaline-earth sulphide in presence of water to the action of carbon dioxide, thereby generating hydrogen sulphide and precipitating the carbonate of the alkaline-earth metal, conducting said hydrogen sulphide into the presence of copper in solution, thereby precipitating copper sulphide and forming a solvent liquid, treating copper ores with said solvent liquid, and collecting said alkaline-earth carbonate and reconverting it into sulphide.

740014—September 29, 1903. J. Herman. *Process of treating ores.*

A process of extracting copper from ores, which consists in treating ore containing iron to produce ferrous chloride, utilizing the chloride and free acid to dissolve carbonates and oxides of copper, the free acid being adapted to neutralize interfering substances and to attack the surface of the particles of copper oxide or carbonate, and regenerating the free acid by the electrolytic precipitation of copper.

740372—September 29, 1903. C. Rogers. *Process of extracting zinc from sulphide ores, etc.*

The process for the extraction and recovery of zinc from zinc containing sulphide ores or tailings, which consists in subjecting the same to a partial sulphatizing roast, discharging the same while hot into water, leaching the same with said water and with dilute sulphuric acid, subjecting the leached ores or tailings to a second sulphatizing roast, releaching the same with the lixivium from the former leaching, and repeating said operations until sufficient zinc and sulphur are removed.

740761—October 6, 1903. A. M. G. Sebillot. *Treatment of sulphide ores.*

A process for treating ores containing sulphur consisting of sulphating the ore in a closed vessel by the action of sulphuric acid upon the metallic sulphides at a temperature above its boiling point and simultaneously recovering the sulphuric acid used, calcining the sulphated ore at a temperature of 700° Centigrade to dissociate the sulphate of iron to prevent dissolving of a too great quantity of sulphate of iron in the lixiviating liquors, and then lixiviating the calcined ore.

748962—January 5, 1904. A. M. G. Sebillot. *Process of treating copper ores.*

The process for extracting pure metals from mineral ores, consisting in treating the ores with sulphuric acid at the evaporating point of the latter, without roasting, to form sulphates, condensing the surplus acids fumes, and lixiviating the sulphates in successively deeper baths under constant agitation, in a current flowing in direction opposite to the progress of the ores.

749760—January 12, 1904. P. Naef. *Process of lixiviating ores.*

The method of lixiviating ores or other pulverulent materials, which consists in passing the ore downward in thinly divided layers through an ascending stream of leaching solution and at the same time passing a current of air or gas repeatedly through the ore layers in numerously divided jets, whereby the ore particles are agitated in the solution, and the same volume of gas acts successively as an agitating medium.

753320—February 16, 1904. J. B. de Alzugaray. *Extraction of metals from complex ores.*

In the treatment o complex ores, such, for instance, as contain copper, lead, silver, and zinc in comparatively large quantities, the process of extracting the said metals selectively, which consists in leaching the ore with a solution composed of a mixture of a chloride of an alkali or earth-alkali metal with a chloride of a metal other than those of the alkali or earth-alkali series and an acid before calcination or roasting whereby the copper is obtained in solution, then washing and drying the ore, roasting the partially disintegrated ore at a low temperature, extracting the metals from the roasted ore in form of salts by means of a second and weaker leaching solution having a character consonant with the nature of the salt it is desired to obtain, and recovering the metals in the usual way.

754643—March 15, 1904. K. Danziger. *Process of separating iron pyrites from zinc-blende.*

A process for separating iron pyrite from zinc-blende, which consists in exposing the zinc-blende to the action of air moisture and heat, and extracting the ferrous salt which has been formed by the oxidizing action by water.

755871—March 29, 1904. T. A. Helm. *Apparatus for treating ore.*

An apparatus for treating pulverized auriferous ores, comprising a rotatable cylindrical tank, radially depending blades in the tank extending the length thereof, a circular brace-frame disposed between the inner ends of the radial blades, an air pipe leading into the tank, faucets to draw off a liquid from the tank, and means to rotate the tank.

CLASS 75.—METALLURGY.

Subclass 86.—Solution and precipitation—Apparatus.

108158—October 11, 1870. W. S. Laighton. *Improvement in apparatus for precipitating gold and silver from solutions.*

The invention consists in combining two vessels—one to receive the solution to be precipitated and the other the precipitant—and connecting them by an automatic apparatus that shall deliver a certain quantity of the precipitant into the other vessel every time it is filled and provide for the discharging of the same, the quantity of the solution that receives the precipitant, measured out, b ing governed by a hydrometer or hydrometric float, which is used to operate the apparatus.

213382—March 18, 1879. C. C. Bruner. *Improvement in apparatus for obtaining metallic copper from its solution.*

The invention relates to a novel apparatus for obtaining metallic copper from its solution; and it consists in the employment of a tank or vat having a horizontal perforated diaphragm, upon which is placed a quantity of iron. This tank is filled with a solution of copper, previously prepared from the roasted ore in the usual manner. Through the top of this tank a steam pipe passes and extends below the diaphragm, so that the solution is heated by this injected steam, and, by the motion which its action gives, the deposition of the copper is hastened. By means of peculiarly arranged slides the steam is admitted above the diaphragm through holes in the steam pipe to assist the process, if desired.

234073—November 2, 1880. R. Schulder and E. H. Russell. *Ore-leacher.*

The invention consists of a circular frame supporting the filter and moving on a circular track above an inclined circular table; and it consists, further, of three stationary rollers, designed to elevate and depress the filter at certain points as it revolves, of a device for feeding the substance to be leached upon the filter, of a device for applying the leaching solvent, and of a precipitating tank to contain the solution passing through the filter.

248768—October 25, 1881. J. F. N. Macay. *Filter.*

The invention relates to improved apparatus for use in effecting the operations of dissolving solids in liquids and producing chemical reactions, and of filtering or separating liquids from solids in chemical and metallurgical processes, in which a soluble substance or substances, mixed or combined with an insoluble substance or substances, is or are to be dissolved separately or together, wholly or partially, in a given solvent or solvents, and the solution separated by filtration from the undissolved residue.

In effecting the separation of liquid from solid matters by filtration it is of importance to keep the filtering surface from being clogged by the particles of solid matter, and to present a clear and unobstructed filtering surface for effecting the rapid separation of the liquid from the solid matters. In the apparatus of the invention this important condition is realized in a very effective manner, the construction and operation of the apparatus being as follows:

Within a cylinder of wood or other material not chemically acted on by the materials treated or the reagents employed is inclosed an inner cylinder of hard wood, or of hard earthenware or stoneware or other material not chemically acted on by the materials treated or the reagents employed, this inner cylinder being perforated with holes and lined internally or externally, but preferably internally, with asbestos cloth or other suitable filtering material.

Between the inner and outer cylinder there is an annular space, and the inner cylinder is kept in place by longitudinal and circumferential partitions, the former of which divide the annular space into a number of distinct compartments, each provided with a draw-off cock for running off the liquid when separated by filtration. This cylinder is capable of being rotated, and is provided with doors or manholes in one of the heads by which the matters to be treated may be introduced and the undissolved residue removed; and the cylinder is also provided with a tubular journal or journals for the introduction of steam, water, air, or other liquids or gases, under pressure or otherwise, which may be blown, forced, or drawn into the annular space for the purpose of keeping the filtering surface clear and of acting chemically or mechanically upon the contents of the cylinder. I place within the inner cylinder the ore or other matter to be treated (previously ground or otherwise reduced to a pulverulent state), together with the reagents or solvents by which it is to be treated. By imparting rotary motion to the cylinder (the draw-off cocks and manholes being closed) the solid matters are brought into intimate contact with the solvents or reagents, and by forcing steam, water, air, or other liquids or gases into the space between the inner and outer cylinders, and thence through the filtering medium into the inner cylinder, any solid matters that may adhere to the filtering surface are disengaged therefrom, whereby the said surface is kept clear, the solid matters are kept in suspension in the liquid, and chemical action, which the liquid or gaseous reagents may be capable of exerting on the said matters, takes place under the most favorable circumstances as regards the intimate mixture of the reagents with the matters and the large surfaces exposed to their action. The annular space between the inner and outer cylinders being divided into compartments by longitudinal divisions, the liquid which passes through into it is carried round by the rotation of the cylinder and flows back into the inner cylinder, thus helping to keep the filtering surface clear and unobstructed. When the soluble substances are dissolved or chemically acted upon, and it is desired to separate the liquid from the solid matters, the draw-off cocks are opened, and then, by giving a slow rotary motion to the apparatus, the liquid may be decanted off from the bulk of the solid matter and at the same time filtered from any such matters which it may hold in suspension by passing through the filtering medium. By this rotary decanting action a practically clear filtering surface, unobstructed by solid matter, is constantly presented for the liquid to pass through.

251718—January 3, 1882. A. E. Jones. *Apparatus for separating gold from quartz and rock tailings.*

The invention consists in the arrangement and application of a suitable fibrous material in combination with machinery, so that the fibrous material will unite or collect to itself the gold and carry and deposit the same to a place designated, where it may be collected and treated as desired in separating the precious metal from its sand and ore. Any fibrous matter that will form a pulp when mixed with water is used to coat a wire-cloth screen as in paper making, and then entangle the fine gold in suspension in the water.

301460—July 1, 1884. J. L. Russell. *Slime filter.*

The invention consists of a trough containing at intervals within it a series of double filtering boxes covered with wire gauze and filled with charcoal, sponge, or any known filtering substance, and the claims cover the trough poised over filter sections provided with adjustable partitions, as well as the combination of a sand box, a sluice provided with adjustable partitions, filters composed of frames and wire gauzes, and gutters.

325835—September 8, 1885. H. C. and J. A. Henderson. *Apparatus for concentrating ores.*

The apparatus for concentrating ores, consisting of an outer tank, an inner filtering tank, provided with fabric ends, and a perforated feed box having its lower end below the top edge of the tank, a space being left between the sides, ends, and bottom of the tanks whereby, when the water is received by the perforated feed box, it will pass into the inner tank and slowly filter through the fabric ends thereof and flow over the top edge of the outer tank, the fabric ends preventing the formation of a current and causing the particles of ore to be precipitated.

366103—July 5, 1887. O. Hofmann. *Process of extracting silver from its ores by lixiviation.*

The invention relates to a certain improvement in the lixiviation process by which the ore, after having been subjected to a chloridizing roasting, is introduced in a series of troughs, first, together with water to dissolve the base-metal chlorides, and, second, together with the solution used in the ordinary lixiviation process to dissolve the silver. The ore and water are introduced either by means of a mixing box or an agitator, and are allowed to flow in these troughs for some distance, and finally conveyed by them into settling tanks. The water while running in the troughs dissolves the base-metal chlorides. In the settling tanks the ore separates quickly from the liquid. The latter is drawn off and conveyed to other tanks for the usual treatment. The ore sediment containing the silver is now sluiced or charged again in a similar series of troughs with a solution which has the property of dissolving chloride of silver, like hyposulphite of lime or soda, concentrated salt solution, Russel's "extra solution" (a compound of hyposulphite of lime or soda and bluestone), etc. By passing through this second series of troughs the silver chloride dissolves. Ore and solution run into tanks which are provided with filter bottoms and allowed to separate. The tailings settle to the bottom, while the clear solution, now containing the silver, is drawn off and conveyed into the precipitation tanks for the usual treatment.

370874—October 4, 1887. F. F. Hunt. *Apparatus for agitating solutions in the leaching of metals from their ores.*

The invention relates to an improvement in apparatus for agitating the acid solutions formed in the leaching of copper and other ores; and the object of the same is to provide a form of rotary agitator in which the heavier portions of the charge can not accumulate at the center of the apparatus and escape the action of the agitating arms, which will also produce a more perfect agitation of the solutions than has heretofore been possible, and which will be more durable and economical to construct than the forms in present use.

Heretofore the agitators used in leaching works have usually been made with flat bottoms and have been provided with stirring or agitating arms of conical shape at the base, arranged to rotate a slight distance above the bottom. In the invention this arrangement is reversed, and the agitating tank is constructed with a cone of small altitude placed apex upward in the center of the bottom and covering a considerable portion thereof, and is provided with agitators, the arms of which are provided with concave shoes and are arranged to rotate in close proximity to the cone in the bottom of the tank.

412610—October 8, 1889. J. B. Hannay. *Apparatus for applying chlorine to the extraction of gold from ores.*

This invention relates to means of extracting from ores precious metals, especially gold, in the form of chloride solution. For this purpose an apparatus is employed which consists of a chlorinating vessel, a set of circulating pumps, a filter press, and a chlorine pump, or sets of these, with suitable communicating pipes, cocks, and valves for operating in the following manner: Having reduced the ore to a fine powder, it is mixed with water or with chlorinated water to a condition of thin sludge, which can be pumped. Then charge the chlorinating vessel with this sludge and apply the pumps to cause its circulation therein, drawing from the upper part and discharging into the lower part, while chlorine gas is pumped into the vessel, preferably to a pressure considerably above that of the atmosphere. After circulation has gone on for some time, until the metal in the ore is mostly dissolved by the chlorine, the sludge is pumped by the circulating pumps into the filter press, additional pressure being given, if required, by using the chlorine pump to force air into the upper part of the chlorinating vessel. The liquid issuing from the filter press containing in solution the metallic chloride is treated in any of the known ways for separating the metal and recovering the chlorine. In some cases the solution discharged from the filter press may be used in a subsequent operation to form the sludge by its admixture with a fresh quantity of pulverized ore, and this may be done repeatedly, so as to obtain finally a filtered liquor rich in chloride.

As it is advantageous to charge the chlorinating vessel with an excess of chlorine above that which enters into combination with the metals, the inventor prefers to collect such excess before discharging the sludge by blowing in a little steam to warm the sludge and allowing the free chlorine thus liberated to pass either into a gasometer or into another chlorinating vessel; or an exhaust pump may be employed to draw off the free chlorine.

When metals such as silver are present, having insoluble chlorides, the blocks which are taken from the filter press, and which contain these chlorides, may be reduced to sludge, as before mentioned, and may be subjected to the same treatment with a suitable solvent instead of the chlorine.

418138—December 24, 1889. J. S. MacArthur. *Metallurgical filter.*

A metallurgical filtering apparatus for separating a precious metal from a solution containing said metal, consisting of a series of vessels, each of which has an inlet tube near its bottom, an outlet tube near its top, and a perforated false bottom above the inlet tube, zinc sponges disposed in the several vessels, pipes connecting the inlet and outlet tubes of the several vessels, and a reservoir for supplying the solution to the first vessel of the series.

425026—April 8, 1890. D. Dennis and T. K. Rose. *Apparatus for leaching ores.*

In a leaching apparatus, a movable table, having a flange or wall projecting from its upper surface to form a receptacle for filtering material, the said receptacle being of less diameter than the upper surface of the table, whereby a packing receiving ledge projects beyond the base of the said wall or flange, combined with the leaching cylinder, the lower end of which is constructed to receive said wall or flange, while the ledge abuts against said lower end of the cylinder.

442263—December 9, 1890. S. Trivick. *Apparatus for treating ores to obtain precious metals therefrom.*

This invention relates to improvements in apparatus forming a plant for treating roasted ground ores to obtain precious metals therefrom, adapted for use in treating roasted ground ores of precious metals that have been roasted by any known or suitable method.

The apparatus consists, essentially, of a vessel (preferably employing a pair at least of such vessels, so as to change from one to the other of the pair in working) having a porous bottom on which the ground roasted ores rest; means of supply of leaching liquid controlled by valve; means of drawing off leached liquid, conveyance thereof to, and means of stirring said liquid in a mixing chamber—a filter vessel having a porous floor—and means of pumping the filtered liquid to a reservoir; means of evaporating the leaching liquor to recover the contained salts; also recovering the copper salts for reuse, and means of heating the leaching liquid, and also means of desiccating the product.

. The invention also consists in a furnace for roasting ores of precious metals, comprising, among other features, a chamber, coils of piping, a tank, reservoir, a force pump, a system of heating pipes, leaching reservoir, tanks with porous floors, and a mixing vessel with rotating stirrers therein.

449813—April 7, 1891. J. Cragg. *Apparatus for extracting gold or silver from ores.*

In an apparatus for extracting gold or other metals from their ores in solution, a tower and a mixer, which consists of a trough having pipes to conduct the reagents in liquid solution, which enter the same from different sides and terminate out of alignment about centrally of the trough, combined with a hopper placed over the ends of the said pipes and an overflow plate leading to the said tower.

456323—July 21, 1891. P. L. Gibbs. *Ore leaching machine.*

This invention has reference to ore leaching machines in which a rotating annular series of ore receptacles pass successively under an ore vat containing the crushed ore in a solution to receive their respective contents or to be otherwise filled, and to discharge the filtrate during their transit into a suitably placed discharging conduit or launder and at a predetermined point in their orbital movement and automatically discharge the residuum.

The objects of this improvement are, first, to provide a suitably suspended vat to receive the ore in a solution, or dry or roasted ore, and adapted by suitable openings in the bottom thereof to optionally discharge said contents; second, to provide a series of leaching vats to pass successively under said primary vat and respectively receive from the latter a proper quantity of its contents; third, to provide suitable mechanism for supporting and progressing said secondary vats; fourth, to provide a conduit or launder to receive and carry off the filtrate from said leaching or secondary vats; and, fifth, to afford facilities to automatically discharge the residuum from said leaching vats preparatory to their refilling.

463120—November 10, 1891. D. Dennis. *Leaching vat for separating precious metals from their ores.*

An ore leaching apparatus consisting of a closed vat or separating vessel having a removable bottom carrying a filter bed in its upper portion and an auxiliary chamber beneath, provided with a removable bottom and a filter bed, and a suitable pipe connection between the separating vessel and said auxiliary chamber in its bottom.

464672—December 8, 1891. W. D. Bohm. *Apparatus for separating gold and silver from ore.*

The inventor places the powdered or divided ore, or material to be treated for the obtainment of the gold or silver, or both, in a vessel or vat, or vessels or vats, and through it passes the leaching solution, preferably previously heated. By means of a force pump, the leaching solution is forced up through the ore and through a filter at the top. The solution and the precious metal which it now contains pass into a vessel in which it is agitated with a precipitating agent. From this last-named vessel the solution is forced up by a force pump through a vessel having a filtering arrangement, such as a porous diaphragm, at the top, so that the solid matter is retained thereby, the liquid passing off to be heated again and to be restrengthened by the addition of the necessary further quantity of leaching chemicals and passed back to the leaching vat or vats for reuse. The pressure under which the liquids are forced up through the leaching vat and precipitant vessel should be at least eighteen pounds per square inch. At intervals the solid matter retained by the last-named filtering vessel is passed into a filter press or equivalent apparatus, whereby it is deprived of the greater part of its moisture. The ore which has been leached is then drained of all solution and washed free from the last traces thereof with water, preferably hot, and then can be washed out of the vat or vats with acidulated water, and passed over zinc or alloy of zinc with other suitable metal, so that hydrogen is evolved, which reduces any precious metal still remaining in the ore to the metallic state, or such state that it is taken up when the ore is afterwards passed over mercury—for instance, over amalgamated copper.

495385—April 11, 1893. F. Webb. *Method of and apparatus for extracting precious metals from their ores.*

The inventor claims, in means for extracting precious metals from their ores, the combination of an outer vessel resting in suitable trunnions for containing the reagent or chemical solution, and having inlet and outlet pipes communicating, respectively, with the top and bottom thereof through said trunnions, a perforated vessel in said outer chamber, and adapted to receive the crushed ore, and provided with a manhole opening extending to the outside of the latter, and means for reciprocating the inner vessel and for rotating the outer vessel on its trunnions, whereby the contents of the inner vessel may be discharged. Also, the method of separating precious metals from their ore, consisting in placing the disintegrated or crushed ore in a closed perforated vessel and causing the latter to reciprocate in the reagent or chemical solution, whereby the latter is enabled to more effectually act upon the ore.

497856—May 23, 1893. C. G. Brown. *Ore tank.*

In a tank for leaching or saturating ore, the combination with a false bottom and a piece of textile material laid upon the upper side of said false bottom; of a series of vertically disposed perforated tubes designed and adapted to hold the pieces of ore apart and promote the circulation of the leaching or saturating solution.

525970—September 11, 1894. J. Storer and B. T. Lacy. *Method of and apparatus for dissolving, leaching, and filtering.*

The inventor claims the improved method of dissolving, leaching, and filtering, consisting, essentially, in connecting a plurality of closed tanks in series, then introducing an expansible medium upon a body of noncompressible fluid contained in a terminal tank to force the said fluid under pressure into the successive tanks and through the material under treatment until it reaches the final tank, then connecting this last-named tank with the initial tank, and finally introducing pressure in the said final tank to force the fluid therefrom so that it may be returned to said initial tank. And in an apparatus for dissolving, leaching, and filtering, the combination of the tank adapted to contain the material to be treated, a tank adapted to contain a noncompressible fluid and connected with a source of steam, gas, or vapor supply, a valve-controlled pipe from said fluid tank to said material-containing tank, a final tank beyond the material-containing tank, a valve-controlled pipe connecting said material-containing tank with said final tank, whereby the fluid is forced into said final tank, a valve-controlled pipe connecting said final tank with the initial fluid tank, and means for admitting an expansive medium into said final tank to force the fluid therefrom back into the initial tank.

530897—December 4, 1894. N. H. Cone. *Filter barrel.*

In an apparatus of the class described, the combination with a revoluble cylinder having a hollow trunnion, and a head provided with radiating channels having independent valves of a filter arranged in said cylinder and valves for opening or closing said channels independently of each other.

536381—April 2, 1895. T. L. Wiswall and J. B. Frank. *Receptacle for recovering precious metals from solutions.*

This invention relates to apparatus wherein the recovery of the precious metals from cyanide and other solutions is effected by passing the solutions through a filtering material, by which the precious metals are precipitated. And the inventor claims, in apparatus for the extraction of precious metals from solutions, the precipitating box, having an undulating, sinuous passage from end to end, comprising a series of alternate angular depressions and elevations, provided with a series of retaining pins, attached to the interior of said precipitating box, and extending into the precipitating, filtering material within said passage.

549177—November 5, 1895. T. L. Wiswall and J. B. Frank. *Apparatus for recovery of precious metals from their solutions.*

The inventors claim, in apparatus for the recovery of precious metals from their solutions a precipitating box adapted to contain a finely subdivided, metallic, precipitating reagent, divided into a series of compartments by removable perforated partitions, said partitions being provided with adjustable gates, controlling the flow of said solution through the perforations in said partitions for the purposes indicated.

549622—November 12, 1895. P. Argall. *Apparatus for extraction of precious metals.*

The specifications set forth that in the treatment of ores by the cyanide process to extract their gold and silver contents, it is the usual practice to place the ores in open leaching tanks and allow the cyanide solution to percolate through the mass and so dissolve and remove the precious metals in solution. This method is on the whole fairly efficient, but it occupies considerable time (forty to eighty hours) and causes a large consumption of cyanide through decomposition, owing to its long contact with the ore and atmosphere. With many classes of ore, however, it is found that agitation of the ore and solution is necessary in order to obtain the best results or largest extraction of precious metals. Particularly is this the case with silver-bearing ores or ores carrying considerable value in silver.

The agitators heretofore in use shorten the time necessary to dissolve the precious metals; but they invariably cause a large consumption of cyanide, due chiefly to the continuous agitation of the solution in open tanks or in partly filled barrels in the presence of an excess of air, while the ore when discharged from the agitators is in such a condition that very often it can not be leached, or at best but part of the cyanide solution containing the dissolved gold can be separated from the ores. Then again, the agitators now in use are of such small capacity as to add largely to the cost of treating the ores.

This invention relates to a new machine for treating ores by continuous agitation and continuous percolation under pressure or by means of vacuum and either with or without external or additional heat. And the inventor claims a percolator for treating ores by the cyanide process comprising an outer shell capable of being closed, air-tight, hollow trunnions upon which said vessel rotates, concentric tubes extending axially through the vessel, the outer tube being covered by a filtering medium, a passage connecting the annular space between the tubes with one of the hollow trunnions, and a pipe communicating with the chamber surrounding the outer tube. The invention includes other features of a minor or subsidiary character.

552867—January 7, 1896. H. G. Williams. *Method of and apparatus for extracting metals from their ores.*

In an apparatus for the extraction of precious metals from their ores by the wet process, the combination of one or more castings, with screw conveyers and mixers, means for feeding the solid and liquid matters thereto, and a dam placed at the discharge end of the casing for each conveyer, having its surface inclined upon the side next to the conveyer flights or blades, for the purpose of maintaining the admixture of the liquids and solids by preventing the liquid from traveling faster than the solid and still giving passage by reason of its incline to the travel of the solids over the same; and, in the extraction of precious metals from their ores by the wet process, the method of continuously and uninterruptedly precipitating and separating the metals, which consists in simultaneously introducing the precipitating agent and an independent agitating blast of steam into the solution of metal in direction as described to secure admixture and agitation by a whirling motion and the agglomeration of the precipitated particles of metal, and continuously separating the precipitate by settlement and filtration.

567145—September 8, 1896. S. B. Ladd. *Apparatus for leaching ores.*

The object of the present invention is to provide an economical and practical apparatus for the lixiviation of ores, and particularly applicable to cases where a large mass of material has to undergo treatment—as, for example, in the lixiviation of low-grade gold ores by the cyanide process—and where the expense of handling material becomes an important factor with respect to the commercial working of the process. The invention applies, generically, to the lixiviation of comminuted or pulverized material of any character, but it is especially designed for the lixiviation of ores by the cyanide process, for in the treatment of ore pulp or slimes by the cyanide and other like processes a large amount of material, often of a low grade, has to be subjected to the action of an aqueous solution of a cyanide or other solvent, or to the successive action of a series of solutions. The common course of procedure in working the cyanide process on a large scale is to run the ore pulp into large vats and then to cause the proper solutions for leaching out the precious metals to percolate therethrough, for example, first an alkaline solution, when the ore is acid, then a strong solution, then a weaker solution, and finally water to wash the pulp. The vat is then emptied and refilled with fresh ore pulp; also, the solvent process is sometimes worked by agitating the pulp and leaching solution in pans or vessels. Both systems require considerable labor and are intermittent.

Another object of the present invention is to provide means to make the extraction process continuous, so that the ore pulp shall progressively and continuously be associated with the solutions or the washings which may be necessary for thoroughly exhausting the values from the ore. This is accomplished by constructing a leaching tank, in the form of a long trough, which may be divided by one or more fixed or removable bridges into so many trough sections as are required for the several solutions or washings when one leaching is not sufficient; or by providing a series of tanks or troughs operatively arranged with respect to each other, employing in connection therewith a conveyer for the ore pulp adapted to continuously feed the pulp with a steady movement through the several solutions in an uninterrupted flow through the apparatus to the point of discharge without any intermediate stoppage or handling of the same whereby the lixiviation of the ore is effected.

For the purpose of rendering the operation continuous, provision is made for a constant drawing off of the charged solution or solutions from the leaching troughs and an inflow of fresh solution thereto. In the case of the first cyanide solution the inflow is preferably at the ore-entrance end of the trough or trough section and the current is with the ore, thus catching the fine float gold carried by the fresh pulp; but in the subsequent troughs or trough sections, and also in the first, if preferred, the inflow of the solution (or washing water) is preferably made at the ore-exit end and the outflow of the solution is at the opposite end where fresh ore or pulp is entering the trough or trough section. Thus, in this latter case, the flow of the solution is opposite to that of the ore. The fresh cyanide solution first acts upon pulp which is largely leached out, and as the solution becomes more and more charged with the gold or precious metals it meets pulp that is progressively richer in the metals, and the conditions are therefore favorable for effecting a complete extraction of the precious metals by the solvent. As a preferred form of conveyer, slowly-moving blades transverse to the trough or tank are used. These blades extend across the tank with just enough room at the sides for clearance, and they reach from above the surface of the solution down to and into the ore pulp on the bottom of the tank with openings or notches in or along the lower part of the blades for the underflow of the solution. These blades divide the trough or tank into a number of communicating divisions and form what may be called "traveling partitions," moving slowly through the trough from end to end thereof. The lower edges of these blades are preferably fashioned with rake teeth, and they open up and rake along the layer of ore pulp on the bottom of the tank and effect a slow and progressive movement of the mass with a constant plowing therethrough and exposure of fresh portions thereof to the action of the solution, while the solution in the tank as the series of blades move forward has to flow back through the notches or openings in the bottom of the traveling blades from each of these divisions formed by the blades, respectively, into the adjacent rear division, and thus there is secured a constant and steady underflow of the solution in close proximity to the agitated pulp. This flow of the solution is in addition to and distinct from the flow due to the constant addition of fresh solvent at one end of the trough and the drawing off of the charged solution at the other end thereof; but it will be seen that the underflow thus effected prevents a mere surface flow of the solution from one end of the trough to the other. On the contrary, as the flow from the respective divisions of the trough is from the bottom and under each traveling partition or blade, the overflow or discharge from the trough at the end is necessarily of the charged portion of the solution. It will be seen that this method of leaching ores places the ore and the solvent under perfect control, which is a very great advantage with respect to the economical leaching of ores. There is an agitation and constant shifting of the pulp in the solution, which very much accelerates the action of the solvent and shortens the time required therefor, and the speed of the conveyer can be regulated so that the pulp will not remain in the tank or tanks any longer than is necessary, and yet long enough for the extraction of all value therefrom. On the other hand, the flow of the solvent through a tank can be gauged so that it will issue from the tank fully charged or charged to the degree most profitable under all the conditions of the case.

576118—February 2, 1897. W. F. Heathman. *Means for extracting gold and silver from sea water.*

In order to extract said metals, the sea water or salt lake water is passed through a filter made of carbon, and the gold and silver held in solution in the sea water or salt lake water are freed from the chemical combinations in which they occur in the water. The chlorides and bromides of gold and silver in solution when passing through the carbon filter are decomposed by the reducing power of the carbon, the liberation of chlorine, and the destruction of the bromine combination, with the result that metallic gold and silver are precipitated in the carbon filter and deposited in the pores and upon the surface of the carbon. And the inventor claims a tank mounted on suitable supports and provided in its side with an inwardly opening valve or gate, said tank having a perforated bottom, and a filtering medium arranged on the bottom and comprising alternating layers of coarse and fine carbon, a layer of wire cloth, and a perforated top covering.

584627—June 15, 1897. J. J. Deeble. *Apparatus for extracting gold from auriferous material.*

This invention has been devised in order to provide a machine for use in the extraction of gold from auriferous material by the aid of chemical solvents, in order to insure the particles of auriferous material being brought into intimate contact with the cyanide or other solvent solution. It includes a vat or pan to receive the auriferous material to be treated, having at or about its center a vertical shaft or spindle with one or more agitators or stirrers attached to its lower end. Motion is imparted to this shaft or spindle by bevel gearing or other convenient mechanical contrivances, and means are provided for reversing the rotation and controlling the speed of the agitators, as well as for raising or lowering the agitator shaft or spindle. These means may consist of a screw-threaded lifting rod with correspondingly threaded bevel wheel in gear with a bevel pinion fitted with a crank handle, whereby it may be rotated in the required direction; or, if preferred, a rack and pinion may be used for the purpose. The inner side of the wall of this vat or pan is provided with a series of projections which produce eddies or swirls in the material under treatment as it is carried round the vat or pan. In order to drain or draw off the gold-bearing solvent from said vat, it is provided with a vertically sliding valve. A waste discharge valve may also be provided in the lower part of the vat or pan for the purpose of enabling the waste material to be sluiced therefrom after the gold has been dissolved and the gold-bearing solution has been drawn off through the valve above referred to.

587403—August 3, 1897. H. L. Sulman. *Method of recovering precious metals from their solutions.*

This invention has for its object the recovery of precious metals from solutions of the same by means of a new and improved apparatus, the apparatus being constructed to effect the deposition or "precipitation" of the precious metal or metals in solution upon a "precipitating" substance or "precipitant" which is in a solid but more or less finely divided state.

The apparatus is designed to recover these metals from solutions of their haloids by means of the employment therein of dense but more or less finely divided carbon, subsulphide of copper, or other suitable precipitant; again, also, for the recovery of the same metals from their cyanide solutions by means of the finely divided zinc product commercially known as "zinc fume," and generally for analogous requirements.

It is necessary that whatever the nature of the precipitant used and the degree of fineness to which it is found desirable to reduce it primarily, it shall be of greater specific gravity than the liquid or solution desired to be precipitated by it, so that the precipitant shall tend to settle from the liquor by gravitation. Further, it is necessary to this invention that the solution or liquor to be precipitated shall percolate upward through the mass of solid finely divided precipitant.

In an apparatus with parallel vertical sides the upward flow of liquor would tend to carry off finely divided particles of precipitant unless special means were taken to prevent this. Filters tend to become clogged and are generally useless for this purpose, so that the inventor retains the particles of the solid precipitant, upon whose surfaces the precious metals are in course of deposition, within the apparatus by inducing subsidence of them. This is effected by continually reducing the upward rate of liquor flow, which is secured by constantly increasing the area of the liquor column as it rises higher in the apparatus.

The apparatus takes the form of a funnel. The liquor enters (under a sufficient pressure or "head") through the bottom orifice. It then meets with and thoroughly mixes with the mass of finely divided precipitant in a condition of suspension in the liquor. The solid, finely divided particles do not sink against the comparatively rapid inflow, or are prevented from doing so to any extent, by means of an automatic valve of ordinary type. By this intimate admixture of liquor with precipitant the deposition of the precious metals in solution in the former is effected upon the minute surfaces of the latter. It now only remains to remove the depleted liquor from the particles of the solid precipitant containing the gold, silver, etc. As the liquor continues its upward flow by virtue of the continually diverging sides of the apparatus the area of the liquor column becomes greater and greater. The rate of the vertical upflow is thereby correspondingly reduced. This continues until a point is reached at which the upflow is vertically so slow that the finest particles are able to settle or subside against it. At any point, therefore, above this limit or "zone" the absolutely clear liquid may be drawn off from the apparatus free from suspended particles and depleted of its precious-metal contents.

If the precipitation of the precious metals be deemed to be incomplete in one apparatus, owing to the richness of the original liquor or to other causes, the outflow may be caused to pass into a second similarly arranged apparatus or through two or more such apparatus placed in series; but in general one apparatus can be made to secure practically perfect removal of the precious metals dissolved in a given liquor by the use of a suitable precipitant. If a series of two or more of such apparatus be employed, the first of the series may be used to enrich quantities of precipitant which have only been partially used up to their fullest capacity of precipitating the precious metals, while the succeeding members of the series are supplied with the necessary amounts of less rich or quite fresh precipitant in order to remove any remaining traces of gold, silver, etc., which may escape unprecipitated in the outflow from the first apparatus. The poorer precipitates in these last apparatus are in course of time removed through the bottom of the apparatus and transferred to the first one of the series, there to be enriched to their full capacity, while their place is taken by fresh quantities of poorer or quite unused precipitating agent, and so on.

When the precipitate is deemed to be sufficiently rich, it is removed from the apparatus by a "three-way cock" at the bottom thereof, or by other suitable arrangement, and the precious metal it contains finally recovered by any suitable method, such as in the case of the employment of a carbon precipitant by burning, or in the case of the use of a zinc precipitant by smelting.

The apparatus is also supplied with a small central funnel for the introduction of fresh quantities of precipitant from time to time to the point of maximum precipitating action in the apparatus, i. e., near the inflow. By providing this funnel with a bell-shaped or inverted-funnel termination a sort of "chamber" is produced in the lower part of the apparatus having an annular space for the passage of liquors between the rim of the smaller funnel and the sides of the large one. This chamber is of considerable aid in promoting the action of the precipitant by keeping the bulk of it constantly near the liquor inflow and securing perfect admixture by means of the vortex currents, etc., it induces. It is further desirable to break up the rapid rush of inflowing liquors at their point of entry into the apparatus, and to secure their subdivision and intimate admixture with the precipitant as early as possible. This is effected by capping the end of the inlet pipe with a small perforated cone or "distributer." The perforations may be from one-fourth to one-tenth the diameter of the inlet pipe, but their total area must be larger than that of the sectional area of the pipe. The holes may be bored in a direction perpendicular to the cap cone or they may be made "tangential," i. e., bored at a tangent to the internal circumference of the cone, thus securing a rotary initial flow of the inflowing liquors instead of a series of straight streams. In the majority of cases, however, perpendicular bore holes answer equally well.

The clear precipitated liquor may be drawn off at any point above the limit of subsidence either by a pipe, or, preferably, by allowing it to flow equally over the rim circumference of the apparatus. The latter method secures the quieter and more uniform outflow and does not disturb the top layers of liquor undergoing final subsidence by establishing a quick current in one particular direction.

If desired, the rim may be encircled with a filter screen of lawn, calico, or other filtering or straining medium, so as to retain within the apparatus any particles of precipitant which may be floated or "buoyed up" by bubbles of air or other gas.

The clear liquors passing over the rim and through the precautionary filter or strainer fall into and are collected by a circular trough or "launder," attached to the apparatus below the rim, whence they are conveyed away by a pipe. As before stated, this may lead into a storage vat or into another similar apparatus, or, if deposition of the floating particles is not absolutely complete, into any suitable type of apparatus—such, for example, as the slat-partitioned tank used for freeing softened water from traces of deposit—where subsidence is finally rendered absolute. In most cases where the traces of precipitant have escaped, I have secured perfect final subsidence by allowing the liquors to flow through a shallow plain tank of from four to six times the area of the top of the precipitating apparatus before passing them direct to the storage liquor vats.

Such an apparatus as is described is termed a "precipitating cone." It may be constructed of any suitable material, such as wood, stoneware, galvanized iron, etc., according to the nature of the liquor or precipitant it is designed to treat. Its action, until the charge of precipitant it contains is exhausted and requires renewal, is perfectly automatic and continuous. Its capacity, its height, the angle of its sides, the ratio diameter of inflow pipe to top area of cone will naturally vary with the volume of liquor to be dealt with, the rate and head of liquor inflow, the relation of the specific gravity of the liquor to that of the finely divided precipitant, the actual coarseness or fineness of the particles of the latter, and so on. These data may be calculated or decided by preliminary experiment in any particular case. As an example, however, of the application of this invention to the recovery of gold bullion from cyanide solutions, the following dimensions of the apparatus are cited: For a flow of from 600 to 800 gallons per hour a depth of 5 feet, with a top diameter of 5 feet, is amply sufficient. The diameter of the inlet pipe is from 1¼ to 1½ inches, according to the head of the inlet liquor, while the perforations of the cap cone or distributer are three-sixteenths of 1 inch in diameter. The charge of zinc fume in such an apparatus varies from 5 to 30 pounds, according to requirements.

587874—August 10, 1897. E. D. Sloan. *Barrel filter.*

The object of this improvement is to provide a suitable filter barrel, with a durable and highly effective filter, at comparatively low cost. With a view to securing the desired ends the usual trunnioned iron barrel is lined with lead. The framing of the filter bed is composed wholly of suitable wood capable of fairly resisting the action of chlorine and acids, and which may be filled with suitable matter to enable it to better resist the destructive action of the corrosive solutions. The filtering medium is composed of material which resists the solutions, is well protected against undue abrasion due to the action of the solid matter during the rotation of the barrel, and it has its filtering area supported to enable it to safely bear the overlying contents of the barrel by an underlying floor of such metal as will practically resist the action of chlorine and sulphuric acid—as, for instance, a lead floor—and the latter is freely perforated to admit of the prompt discharge of the filtered liquid. The filtering surfaces are flat, and hence the body of any woven filtering medium is maintained in a condition more favorable to the passage of the liquid than would be the case if it occupied a curved line and said surfaces were concave in conformity with the interior contour of the barrel. The framing of the filter bed involves inexpensive straight work as distinguished from the curved or segmental work in framing, which is made to conform to the interior of the barrel as heretofore, and the filter framing is constructed in parts which are so interlocked as to secure rigidity, but which may be readily applied to or removed from the barrel by way of the usual manhole and without deranging the lead lining or the means by which the lining is clamped to the barrel.

597372—January 11, 1898. P. J. Donohue and J. F. Corker. *Precipitating safe.*

The combination with a closed vessel or standpipe provided with a normally closed outlet at its bottom for the precipitate and having a body or column of zinc filings or like material in its upper part, adapted as corroded to fall into the lower part, of means for supplying, under pressure, the solution containing the precious metal to the lower end of the said body or column of filings or like material, to cause the corrosion or oxidation thereof, whereby such corroded or oxidized portions will gradually precipitate to the bottom of the vessel or standpipe and the fresher portions of the filings or like material be exposed to the ascending solution.

606810—July 5, 1898. J. W. Pack. *Recovery of gold from waste solutions of chlorination works.*

A means for recovering gold from waste solutions of chlorination works, consisting of a tank having an inlet passage at the lower portion and an outlet passage at the upper portion and having metallic aluminum contained therein, and intermediate between the inlet and outlet passages of the tank, and a filter fixed within the tank between the metal and the outlet passage and having its lower side coated with a substance which will arrest the fine precipitated gold and prevent it from passing off with the liquid.

608554—August 2, 1898. R. Moodie. *Washing or leaching apparatus.*

In an apparatus for washing or leaching, a series of cells, one of which is a dry cell and the others of which contain washing or leaching liquid, means for introducing the material to be washed into the dry cell, an oscillating shaft extending longitudinally of the series of cells, means operated by said shaft to transfer the material from the dry cell to the washing cell next in series, arms attached to the oscillating shaft and extending one into each washing cell, and scoops on said arms

608945—August 9, 1898. H. B. Williams. *Lixiviation apparatus.*

In a lixiviation apparatus, the combination of a vertical series of annular tanks arranged one above another and each provided with an exit through which ore or other substances may be discharged into the tank beneath, each tank bottom being provided with an ascending incline leading to one side of the tank exit and having a descending incline on the other side, means for feeding ore into the topmost tank, pipes for conveying leaching solution into the several tanks separately, the feed of the ore to be continuous and the feed of the solution to be continuous or intermittent, filters located in the several annular tanks, and automatic scraping and stirring mechanism to cause the ore and solution to be moved around each annular tank and over the filter therein.

610596—September 13, 1898. R. Aymer and D. J. Nevill. *Filter frame.*

In a filter barrel, the combination of a rubber grating having a corrugated surface in contact with the curved inner lining and periphery of said filter barrel adapted to allow the filtering solutions to run along and down the lining of said barrel, a perforated bedplate of glass or porcelain curved concentric with the inner periphery of said barrel and resting on said rubber grating, a filtering medium on said glass bedplate, a curved glass grating resting on said filtering medium, two oppositely disposed cleats secured lengthwise of said barrel to its inner periphery adjacent to the ends of said curved glass bedplate and grating, and wedge keys between said ends and said cleats adapted to key said members against the barrel.

611515—September 27, 1898. J. P. Schuch, Jr. *Means for extracting precious metals.*

In a metallurgical apparatus for treating ore by a cyanide solution, a tiltable tank comprising a suitable support, a tank body having a discharge gate at its rear end and pivoted to the support at a point between its center and the front end, a drain device in the bottom of the tank for drawing off the cyanide solution, holding springs mounted on the support and engaging with the tank body at points between its discharge end and the pivotal connection thereof with the support, and means for retracting the holding springs from engagement with the tank body.

611955—October 4, 1898 J. Poole. *Process of and apparatus for treating ore tailings.*

For the continuous treatment of pulps, slimes, tailings, and the like with cyanide and similar solvent solutions and in combination, a series of shallow tray-like baths, a rake in each bath of the series, means for reciprocating the rakes, an overflow chute at the end of the series, settling tanks to receive the overflow from the chutes, means for separately discharging the solid and liquid contents of the tanks, conveyers adapted to raise the solid contents from one tank after discharge, a launder in which such contents are received and in which they may be further treated with a solvent solution or wash, and a further settling tank for receiving the discharge from the launder.

615968—December 13, 1898. T. Craney. *Apparatus for treating ores, etc.*

In an apparatus for treating ore, the combination of a tank adapted to contain a body of the ore to be treated, devices for feeding ore into the top of said tank and discharging it from the bottom thereof at a point above the tank in a continuous manner, a solvent supply reservoir, a receiver connections between the tank and said supply reservoir, and receiver for producing a continuous flow of the solvent through the tank in a direction opposite to that of the movement of the ore, an endless-chain carrier in proximity to the tank and having draining buckets adapted to receive the ore discharged from the tank, means for discharging a liquid upon the drainage buckets, and means for collecting the drainage from the buckets and returning it to the aforesaid supply reservoir.

617029—January 3, 1899. W. A. Köneman and W. H. Hartley. *Apparatus for separating liquids from solids.*

The method of abstracting liquid from finely pulverized ore, ore slimes, or other solids impervious to percolation with which the liquid is mixed, which consists in subjecting the mixture to gaseous pressure applied above the same, and simultaneously to the action of a partial vacuum applied below the same, removing a portion of the liquid by filtration below the body during compaction of the solids, and collecting and abstracting by pressure the remaining liquid above the compacted solids.

617436—January 10, 1899. P. Argall. *Cyanide filter tank.*

In a cyanide filter tank, a vertical metallic side or wall, a horizontal bottom secured thereto, having a central opening, a packing ring secured to the inside of said wall, near the bottom, with a spacing, a system of level joists converging from the perimeter toward the center, upon said horizontal bottom, a plastic filling between said joists sloping downward from the packing ring regularly toward the central opening, a level floor with interstices laid upon said joists, permeable filtering material upon said floor, and a covering of textile fabric, the outer margin of which is packed into the crevice between the packing ring and the vertical wall.

618622—January 31, 1899. P. Somerville. *Apparatus for extracting metals.*

An apparatus for extracting metals, consisting of parallel barrels having annular disks closing one end with central inlet openings for the material, a framework and roller support for said barrels, means whereby the barrels are rotated in opposite directions, spiral flanges fixed to the interior of the barrels for advancing the material therethrough, devices for feeding material and fluid matter to the uppermost barrel, means for separating the coarse from the fine material and delivering them separately, and means for transferring material from the discharge end of one barrel into the inlet end of the barrel below.

619211—February 7, 1899. A. M. Nicholas. *Filtering apparatus for separating gold and silver bearing solutions.*

This invention has been devised for the purpose of providing means whereby solids or insoluble material may be separated from liquids carrying same in suspension, but more particularly for the purpose of providing means whereby the separation of gold and silver bearing solutions from tailings, slimes, pug, or pulverized ore may be carried on continuously and in such a way that a clean or partially clean filter cloth will be continuously brought into operation without necessitating stoppages for recharging, as required with the appliances at present in use.

The essential feature of the invention consists in the use of a rotating wheel, disk, or table formed with a series of air-tight compartments covered with cloth or other filtering material supported upon a metal screen or perforated plate and adapted to be automatically placed in communication with a vacuum pump in turn for a sufficient time to enable the liquid to be drawn through the filtering material, leaving the solid constituents upon the filtering surface, whence they can subsequently be removed by brushes, jets of water, scrapers, or similar contrivances, provision being made for automatically allowing air to enter into the various compartments at the desired period of the operation to facilitate the removal of the solids from the outer surface of the filtering material.

620560—March 7, 1899. J. Luce. *Apparatus for treating ores by lixiviation.*

In a tank for the treatment of ores, a lining composed of asbestos applied to the inner side of the tank, the notched or recessed boards applied inside of the asbestos, and the steam pipes placed in the notches in the boards, combined with two thicknesses of grooved perforated boards, and the layers of cloth between the boards.

623465—April 18, 1899. G. S. Duncan. *Apparatus for separating gold and silver bearing solutions from ores or slimes.*

Hitherto upward percolation has been used for the displacement of the various gold and silver bearing solutions in the treatment under the cyanide or other similar processes of tailings or free leaching ores which are not in the form of slimes. With this upward percolation false bottoms for the vats with webbing upon them have been used and the solutions have been introduced underneath these false bottoms, which have acted as distributers therefor and allowed them to pass evenly up through the free leaching ore, displacing the gold and silver bearing solution contained therein. This false bottom and webbing are adapted for use with free leaching ores only and can not be employed for displacing solutions used in treating very finely crushed ores or slimes which do not leach freely.

The present invention has been devised in order that the various solutions may be displaced, as above described, from finely crushed ore or slimes, without the aid of any false bottom and filtering-webbing. And the inventor claims, in an apparatus for separating solutions of the precious metals from residual ores and slimes, the combination with a leaching and displacement tank or vat and with a vat to hold said solutions, the latter being placed at a higher level than the former, of a series of pipes to convey said solutions from the higher vat, the discharge ends of said pipes entering the leaching vat, a series of hoods having slightly arched portions which overlie the said discharge ends, and stirring arms radiating from a central shaft in said vat, the arched portions of the hoods being arranged in radial lines, or at right angles to the movement of currents set up by the stirring arms.

623772—April 25, 1899. A. F. Dury. *Apparatus for leaching ores.*

A device for treating pulverized ores, comprising a leaching tank, an air compressor, a tank for storing the leaching liquid, a perforated pipe in the bottom of the leaching tank, connections from the air compressor and liquid storing tank to the perforated pipe, a perforated drainage pipe in the bottom of the tank, and a layer of filtering material about said pipe.

624553—May 9, 1899. C. H. Pead. *Slime filter.*

The apparatus consists of a tank fitted with a hood of conical or any other convenient form. The sides of the tank project above the point of attachment of the hood, so as to form an annular space to act as a receptacle forming a launder for discharge of the clear liquid. In the center of the hood is an opening, around which is riveted or bolted a frame or seating arranged to carry a filter composed of one or more layers of filter cloth or any other well-known filtering medium. The filter is kept in place by means of a protective gird or clamp of suitable form and strength to resist the effective pressure from the interior of the tank. A number of small distribution pipes set at such an angle as to cause the slimes to impinge on the under surface of the filter are connected to the seating of the latter, through which they pass. They are connected to a main distributer, which in turn is connected with the delivery pipe or column of the slime pump. One or more taper shaped plugs or cores constructed of light steel tubes, their number varying according to the size of the tank, pass through the hood and extend to the bottom of the tank. They taper from about 18 inches at the top to 15 inches at the bottom. They are fitted at their upper ends with a flange, to which is attached a shackle. Their lower ends are closed by means of a dished bottom riveted in place and having a strong bolt or stud fitted to its center. Each plug or core rests on a seating fitted to the outside of the hood and through which the plug or core passes. The seating is attached thereto by means of its flange.

In the bottom of the tank and directly under the aperture in the hood through which the plug or core passes is a discharge door of the ordinary manhole or other convenient type. The end of each plug or core passes easily into the discharge opening, and the discharge door is drawn up onto its seating or joint by means of the bolt or stud on bottom of the plug or core and by its nut. The plugs or cores when in place and holding up the manhole doors afford an effectual means of resistance against internal pressure.

A special pipe is arranged and fitted to the upper portion of the tank to drain the space forming a launder between the top of the tank and the upper surface of the hood and to conduct the liquid portion which has passed through the filter to the precipitation boxes or to waste.

624633—May 9, 1899. F. A. Edwardes. *Apparatus for use in treating metallic ores.*

In apparatus for use in the treatment of metallic ores, the combination with an annular vat having a stirrer moving therein and skimmers attached to and moving with the said stirrer, of means for tipping the said vat for discharging the contents.

624957—May 16, 1899. L. H. Mitchell. *Tank bottom discharge door.*

A discharge apparatus for tanks provided with a hollow upper portion, a base having integral bearing zones connected thereto at one end thereof, a casting having an upper annular supporting rim and adapted to receive said bearing zones, a ring surrounding said casting, devices connecting said rim and ring to secure the casting in position, and means supported by said casting to unseat said base.

624958—May 16, 1899. L. H. Mitchell. *Tank bottom discharge door.*

A discharge apparatus for tanks consisting of a casting secured in the bottom of the tank, a ring below the tank around the casting, and means for securing the rim and ring in position, a funnel above the casting, a base connected with the lower end of the funnel and provided with an annular offset or shoulder, a packing ring within the offset, and adapted to rest upon the rim of the casting, a plate or bar bearing against the rim of the casting, a nut carrying screw in the plate or bar adapted to engage the base and draw the same within the casting, a brace or clamp connected to the plate or bar above the nut on the screw, and means for rotating the screw.

639540—December 19, 1899. W. Duncan. *Means for mixing and aerating sands or tailings while under treatment by solvents.*

Numerous attempts have from time to time been made to secure the thorough mixing of sands and tailings, including slimes, with the solvent while under treatment and also to prevent that close packing which prevents the percolation of the solvent and wash liquors. For this purpose vertical vessels with vertical agitators, revolving barrels, and air, steam, and water jets have been used, but these means have not been as efficient as they might be.

This invention relates to improved mechanical means for mixing and aerating "sands" or "tailings," by which terms are included slimes, sludges, and concentrates, while under the action of solvents, whereby time is saved and a better extraction is obtained; and it consists of a semicircular vat provided with a revoluble agitator composed of arms arranged helically on a shaft running the length of the vat. At one end of the vat is placed the fast and loose pulleys and gear for slowing and rotating the agitator, while at the opposite end a series of taps are provided connected to the vat at various heights and to pipes, so that the liquor can be drawn off at any desired point and either run direct to the sump or through a filter to the sump.

641419—January 16, 1900. H. C. Wheeler. *Agitator.*

In an agitator, the combination of the vat, the track provided with the cog rack, the carrier provided with the pinion meshing with the cog rack, the first driving shaft provided with the driving pinion, the driven cogwheel meshing with the driving pinion, the gear wheels connecting the driven cogwheel with the pinion meshing with the cog rack, the agitator frame journaled or pivoted to the carrier frame, the second driving shaft journaled in the agitator frame, the agitators journaled in the agitator frame and adapted to be operated by the second driving shaft, intermediate gearing connecting the second driving shaft with the driven cogwheel, one of such gears being journaled with its axis in line with the axis of the pivotal support of the agitator frame, and means for rotating the first driving shaft.

647358—April 10, 1900. D. W. Balch. *Leaching tank.*

A tank having a bottom, a leaching false bottom above the same, and vertical filtering partitions arranged in pairs within the tank, whereby spaces are left between pairs of partitions, and other spaces are left between members of such pairs, said spaces last named all communicating with the chamber between the bottom and false bottom.

647678—April 17, 1900. C. W. Merrill. *Means for charging leaching vats.*

This invention relates to a method of charging ore or tailings to a leaching vat, which process is a step in the treatment of said ore or tailings preliminary to the application of the solvent solution in cyanide, hyposulphite, or other hydrometallurgical processes.

It consists, essentially, in conveying the tailings or ore by any well-known adaptable mechanical means to a point above the center of the vat to be charged and delivering the material there to a hopper, which feeds a revolving chute inclined at an angle greater than the natural slope of the material to be handled, and with openings adjustable both as to size and position, through which the material to be treated falls gently into the vat and distributes evenly, thus giving a charge of minimum density and maximum homogeneity, the conditions most favorable to successful leaching and dissolution of the precious metals.

The ordinary method of charging leaching vats is from cars running on a superimposed track. By this means the momentum of the carload of tailings or ore dropping through five or more feet to the bottom of the vat is such as to produce considerable packing, and, moreover, an uneven packing or density. For instance, in dumping from an end discharge car the resultant mass of ore or tailings will take the form of a cone in the vat and the maximum density will be in the center of the approximate circle forming the base of the cone and will decrease along the radii toward the circumference of this circle. Furthermore, the variation in fineness of the different carloads is not equalized, and a vat charge of ore or tailings results, which is heterogeneous, both as regards density and as regards fine and coarse material. Now, first, the charge of ore or tailings in a vat should be of the least density possible to obtain, because experience has demonstrated that the greater the permeability, and consequently the greater the amount of lixiviant possible to percolate through the charge, the greater the extraction of the precious metals in a given time, or, from another standpoint, the greater the permeability the less the economic period for leaching, and hence the less the cost for plant and subsequent operation; second, the charge should be as nearly homogeneous as possible as regards both density and size of material, because in leaching ores it is necessary to follow solution with wash water to replace and prevent the loss of the former or to follow one lixiviant with another of different strength or containing a different solvent, and in doing this to maintain the surface of demarcation between the one and the other as nearly a horizontal plane as possible in order to minimize the mixing of effluent solutions. The above conditions of minimum density and maximum homogeneity are produced by means of a revolving inclined wide chute with small openings in the bottom, adjustable as to size and position transverse to the direction of the stream of ore or tailings. By means of this method a number of very small streams of ore or tailings fall gently into the vat as the chute revolves, and by increasing the speed of revolution a carload of fine or coarse material can be spread over the whole area of the vat, thus giving the smallest possible dimension parallel with the course of the lixiviant.

653631—July 10, 1900. J. C. Wallace. *Filter barrel or tank.*

In a filter barrel or tank, a filtering device consisting of a series of curved metal plates, perforated, fastened to the inside wall or walls of said barrel or tank; a filter cloth upon the upper surface of said plates, secured thereon by a series of imposed metal bars and filling strips secured in position by bolts or other fastening devices to the wall or walls of said barrel or tank.

653684—July 17, 1900. F. H. Long. *Metallurgical filter.*

The combination with a closed vessel having a filter septum and a regulated outlet port for the filtrate beyond such septum, of the wash water pipe connected in hydrostatic column with said vessel and the external centrifugal pump joined at its separate sides in closed union with the opposite ends of the vessel, the journal box for said pump axle being furnished with a water column pipe to counterbalance the hydrostatic pressure at the vessel.

654315—July 24, 1900. T. E. Leece. *Apparatus for working ores of valuable metals.*

This invention relates to an apparatus which is designed for working the ores of valuable metals, and is especially useful for separating slimes from solutions in which they may occur, and also for separating heavier and lighter parts under any condition in which they may be found associated.

It consists, essentially, of a tank and an endless traveling belt with directing rollers, by which one portion of the belt is caused to travel through the tank in close proximity with the bottom, and the other part is guided back exterior to the tank by similar rollers. It also comprises a means for straining or separating the liquid from the heavier portions.

660458—October 23, 1900. J. A. Fleming. *Apparatus for leaching ores.*

In an ore leaching apparatus the combination with the leaching tank having a pulp discharge, of the conical perforated filtering hopper therein having the discharge for the pulp, means by which to maintain air pressure below the diaphragm, whereby to control the flow of solution through it, means for the introduction and withdrawal of chemicals to and from the body of the tank above the filtering diaphragm, and devices for controlling the discharge of the pulp from the tank.

660459—October 23, 1900. J. A. Fleming. *Apparatus for leaching ores.*

An ore leaching apparatus, consisting of the leaching tank, having a filtering hopper, a solution discharge below said hopper, and a pulp discharge also below said hopper and independent of the solution discharge, a washing tank below the leaching tank and in position to receive the pulp from the discharge thereof, and means for controlling the passage of the pulp from the leaching to the washing tank.

664059—December 18, 1900. J. P. Schuch, Jr. *Ore mixing machine.*

Heretofore, in treating gold bearing ores by the common cyanide process, the ore is first crushed, dried, and rolled to a proper degree of fineness, and that which requires roasting is then conveyed to the roasters, while the oxidized ore which does not require roasting is conveyed to the bin or receptacle therefor. After the portions of the ore to be roasted have passed through this step of the process the same is conveyed to the cooling room before being deposited in the bin or receptacle referred to which contains the ore requiring no roasting. All of the ore is then removed by manual labor into the ordinary stationary cyaniding tanks, and after these tanks are filled with the ore the cyanide solution is introduced therein. In this process the filled cyanide tanks, with the solution and ore therein, are permitted to remain filled and unmolested for a sufficient length of time for the solution to act on the ore, after which the gold bearing solution is drawn off and allowed to flow to the precipitation room, while the tailings in the tank are then washed with water and shoveled out or sluiced out when this is possible. In this process, which is the one usually followed out in extracting gold and silver from their ores by the use of cyanogen containing solvents, the percentage extracted rarely exceeds 80 per cent of the ore value, and it is the purpose of the present invention to provide means whereby a larger per cent of the value of the ores may be saved.

To this end the invention contemplates an improved mixing machine which provides for a thorough aeration of the ore and solution, while at the same time providing for a mixing of various grades of ore with the cyanide solution, so as to make one even grade out of ores of various values. And the inventor claims, in an ore mixing machine, an open tank provided at the bottom with a solution drain, a perforated false bottom arranged within the tank above the main bottom and supporting filtering material, an ore discharge pipe communicating with the interior of the tank immediately above the plane of the false bottom, a revoluble agitator depending within the tank into close proximity with reference to the false bottom, and a plurality of air jets arranged to communicate with the tank in a plane intermediate the said false bottom and the lower end of the agitator thereabove.

664196—December 18, 1900. J. C. Wallace. *Filter bed.*

In a filter barrel, a filter bed consisting of a series of metal plates having drain slots or perforations therethrough, a series of perforated tiles arranged as a filtering medium upon and supported by said metal plates, a series of metal binding strips imposed upon or against said tiles; together with suitable means for fastening or confining the same together and to the inner wall of a filter barrel or tank.

671028—April 2, 1901. J. R. Phillips. *Pulp agitator.*

This invention consists of an inclined or funnel shaped tank or containing vessel into which the pulp is placed with water, cyanide solution, or other equivalent liquid, a circulating or suction and force pump by which the surface liquid may be drawn from the tank, and a pipe extending centrally down to near the bottom of the cone, with a discharge nozzle through which the liquid is delivered with force, so as to flow upward along the sides of the funnel and through the material, whereby the latter is loosened, agitated, and prevented from packing. In conjunction with this may be used a canvas or equivalent filter lining for the funnel, with means for providing a space intermediate between it and the sides of the funnel for the filtering through of water, and a means for conducting such filtered water away from the apparatus.

680154—August 6, 1901. A. D. Jansen. *Discharge door for cyanide tanks.*

In cyanide treatment the sands are subjected to the action of cyanide solution, which solution after the proper length of time has elapsed is drawn off through a filter composed of matting or some similar material situated at the bottom of the tank. This matting or filtering material does not rest directly on the bottom of the tank, but is supported by a grating or perforated false bottom in order to allow a free passage for the solution which has filtered through. That portion of the tank, therefore, which is situated over the discharge door has no grating or filtering material, and consequently a more or less vertical column of sand is left in the tank, which still contains cyanide solution with gold in solution, the result being that this portion is imperfectly treated.

The object of this invention is to provide a door so constructed that a piece of matting or filtering material may be placed upon it in order that the filtration of the solution shall be just as complete over the discharge door as in the rest of the tank.

This invention furthermore relates to an improved construction whereby the door is rendered much more easily closed and also to a system of packing the same by which the joint between the door and the bottom of the tank is rendered tight.

683412—September 24, 1901. A. J. Perry. *Ore separator.*

The object of this invention is to introduce a mixture of steam and air in the pulp, whereby the precious metal receives a quick chemical action, with the result that considerable time is gained over the method heretofore employed. And the inventor claims, in a leaching apparatus, the combination of a receptacle for holding pulverized ore, an agitator mounted in said receptacle and having a series of radial horizontal pipes each provided with a series of perforations at one side thereof, a series of scrapers or blades mounted on said agitator, a pipe adapted to supply to said agitator a mixture of steam and air from a proper source, and means adapted to rotate said agitator whereby the discharge of steam and air through the perforations of said pipes is directed toward the rear while the said scrapers or blades are moving in the opposite direction.

684654—October 15, 1901. C. Voelker. *Ore filter.*

The extraction of valuable metals from ores through the lixiviation processes, such as the cyanide and others, although allowing the advantageous working of low-grade ores, still has one fault, that more or less metal remains in the tailings, and thus losses occur caused by the slimy particles contained in the pulverized ores generated from clay, talc, and other minerals which clog up the meshes of the filtering cloth, and thus prevent the solution from going through freely. In such apparatus the ore is introduced and the solution added, and where it happens that the ore lies in different grades of value inside the tank, the solution can not dissolve the metalliferous particles in an even manner, and at the same time where it enters first it will affect the pulp more thoroughly, and as it goes down to the bottom will take the slimes forming with it, depositing them around the aperture through which the solution is drawn off, and even several after leachings will not remove them. To overcome these drawbacks it is necessary to construct a mechanical apparatus which shall possess the condition of letting the soluble liquids needed to dissolve the metals go through the pulp in a space of time to be governed by the operator. Some ores are liable to contain chemical substances retarding the effectiveness of the soluble agent used, and where it is of great import to remove them as quickly as posible to keep them from going into chemical action with the solution used.

The object of this invention, therefore, is to combine the above-mentioned conditions, and the apparatus can be used, in addition to other milling plants, to receive the tailings direct from the mill. The filtrate can be examined in regard to the valuable mineral matter which may exist, giving the metallurgist the means of saving the valuable salts of mercury, copper, silver, gold, and the like which may form through the chemical or electrical action in the amalgamators where such are used and where the extravagant use of copper sulphate, mercury, and salt is in most cases the cause of the solubility of gold.

The inventor claims: An ore filter, comprising a funnel shaped tank, a basket or filter holder removably arranged in said tank and fitting closely against its inner wall, a filtering textile stretched over the inner surface of said basket, a top or hood for the tank, a shaft extended downward in the tank, and a screw mounted on said shaft and spaced at its inner edge therefrom, the said screw having the end of its upper turn turned downward.

687920—December 3, 1901. A. D. Jansen. *Apparatus for charging or discharging cyanide vats, etc.*

In combination, the pair of tanks situated one above the other, stirring mechanism for said upper tank, having a hollow supporting or operating mechanism, and stirring mechanism in said lower tank, having its operating mechanism in line with the hollow mechanism of the upper tank, and means for raising said operating mechanism of the lower tank into said hollow mechanism of the upper tank.

688085—December 3, 1901. A. G. Goldsobel, W. Muttermilch, and C. Jablczynski. *Apparatus for the recovery of precious metals from photographic residuum.*

The combination with a vessel having a loose lid, a spout or outlet for the outflow of liquid and a conical bottom and with a precipitating material contained in said vessel, of a tube having a funnel shaped end reaching within said vessel, and of a second tube provided with a cock connecting the aforesaid precipitating vessel and funnel shaped tube with a second vessel or receiver.

689799—December 24, 1901. R. L. Graves. *Ore leaching apparatus.*

The apparatus for use in extracting ores, consisting of a plurality of tanks, a pump, a discharge pipe leading from said pump and having a plurality of branches leading to the several tanks and provided each with a discharge pipe which may be turned axially or swung vertically, valves controlling the several branches, and a flexible supply or suction pipe leading to the pump and arranged to be shifted from tank to tank, levers connected with the several discharge pipes whereby they may be turned axially, and means connected with the lower ends of the discharge pipes whereby they may be swung vertically.

690375—December 31, 1901. G. Rensen, Jr. *Agitating machine for cyaniding.*

An agitating machine for the treatment of gold and silver ore by the cyanide process, comprising an agitating tank, having a conical bottom; a heating chamber surrounding the conical bottom of the agitating tank; means to heat said chamber; a rotary pump, centrally disposed in the agitating tank, adapted to take the solution from the bottom of the tank and discharge it above the top thereof; a rotary deflector, adapted to distribute the solution over a stationary deflector; and a stationary deflector affixed to the casing of the pump, adapted to deflect the solution to near the edge of the agitating tank.

691706—January 21, 1902. F. H. Long. *Metallurgical filter.*

The combination of a vessel having a conical filter-septum and an outlet-port for the filtrate beyond such septum, of means for establishing an end-to-end circulation of the vessel contents above said septum, a conical spreader and an oppositely facing conical baffle plate having a projecting spiral flange successively interposed between the ends of the vessel and arranged adjacent to said conical filter-septum to intimately direct such circulation over the surface thereof.

697178—April 8, 1902. E. L. Sharpneck. *Apparatus for the treatment of ores.*

As a means for facilitating the dissolving of the values in ores, the combination of a leaching tank, a conduit leading from and discharging directly into the tank, and means in the conduit connected with a heating medium supply for agitating, circulating, and heating the liquid contents of the tank.

698016—April 22, 1902. J. J. Hervey. *Cyanide tank.*

Cyanide tank having a tapering bottom and a central cone arranged in connection with the bottom, an annular lining arranged in the tank and open at its lower end, a filtering screen connecting the lower end of the lining and the central cone, the air and water pipes, the charging and discharging pipes, and the forcing means connected with said pipes.

699211—May 6, 1902. De W. C. Mosher. *Barrel filter.*

The combination with the lead lining of a filter barrel, of filter sections or plates having projections on their outer sides and perforations through the plates between the projections, and having bent ends, whereby the plates may be united to the lining by burning.

699212—May 6, 1902. De W. C. Mosher. *Barrel filter.*

The combination with the lining of a filter barrel, of perforated filter sections, and means for supporting said sections and securing them to the lining, said sections having their adjacent ends so constructed and arranged to form a longitudinal channel.

701239—May 27, 1902. F. D. Wood. *Means for working ores by the cyanide process.*

An apparatus for treating ores consisting in combination of a plurality of aligned containing tanks, a transversely concaved endless belt passing through and returning beneath each of said tanks, and upon which the ore is carried, each of said belts discharging its load upon the belt of the next succeeding tank, means for driving said belts in unison, means by which said belts are kept transversely distended and rollers disposed at intervals in said troughs and over which the belts pass, whereby the latter are given an undulatory movement.

702664—June 10, 1902. F. H. Long. *Metallurgical filter.*

In metallurgic filters, the combination with the closed perforated tank having an internal fabric septum with stretcher frame therefor to rest against the tank walls of the feed pipe leading into the tank bottom and the separate wash water pressure tube united to said feed pipe between the inlet and outlet valves thereof.

702490—June 17, 1902. R. Sreman. *Apparatus for treating copper ores.*

A plant for the treatment of ores, comprising a safety vessel, a mixer revolubly mounted, a settler revolubly mounted at a lower level than the mixer, and a still revolubly mounted at a lower level than the settler, and pipes connecting the several vessels together, the portions of the several vessels and pipes with which the ammoniacal solution of copper comes in contact being of material indestructible by such solution.

705589—July 29, 1902. A. James. *Apparatus for precipitating gold and silver from their solutions.*

In the precipitation of gold and silver from cyanide and other solutions zinc is usually employed as a precipitant, and the use of iron vessels containing the solutions has been found objectionable, because the iron being electro-negative to zinc a galvanic action is set up between the vessel and the zinc, which causes the precious metal to be deposited upon the vessel instead of upon the precipitant. Owing to this difficulty the general practice has been to use vessels constructed of wood or earthenware, which are inconvenient and do not facilitate the cleaning-up operation.

The object of this invention is to avoid these objections.

To this end the invention consists in a metallurgical filter for separating precious metal from a solution containing it, consisting of a metallic vessel and a zinc sponge disposed therein, said vessel having an inner coating of enamel, whereby galvanic action between the metallic vessel and the zinc is prevented and deposit of precious metal on the vessel avoided.

705726—July 29, 1902. J. C. Wallace. *Filter bed.*

In a filter bed, the combination of a corrugated filter sheet or blanket having numerous perforations through the lower arcs of said corrugations; a series of transverse supporting bars formed to fit under and receive the corrugated contour of said filter sheet; a series of superimposed binding strips or bars with transverse corrugations and slotted ends; two longitudinal side binding strips or bars, and bolts adapted to holding the several members together and in place within a filter barrel or tank.

706334—August 5, 1902. G. Moore. *Apparatus for leaching ores, etc.*

In dissolving the soluble portions of ores, furnace products, and other like materials it has always been difficult in one operation to dissolve the final traces of the soluble portions and at the same time completely utilize the dissolving power of the acid alkali. The weakening of the acid or alkali by its dissolving action makes its action less energetic toward the finish of the operation at the very time when the more difficult soluble particles needing the most energetic dissolving action are acted upon. This not only causes loss of reagent, but also further loss on account of the poor extraction of the soluble elements desired. Also, in the case of ores of a talcose or slimy nature the talcose portions in the form of slimes prevent percolation of the solutions in tanks by clogging. These slimes should be separated and filtered separately by known methods. Then the remaining portion will easily allow percolation.

The object of this invention is to provide an improved apparatus for the purpose of overcoming these difficulties; and with this object in view the invention consists, primarily, in a hollow truncated cone mounted to rotate about a central horizontal axial line, provided with an opening at one end to receive the material to be acted upon, an opening at the opposite end to receive the fluid solvent, means for actuating the material through the cone in one direction and means for actuating the fluid solvent through the cone in the opposite direction simultaneously with the passage of said material.

706472—August 5, 1902. A. E. Johnson. *Filter bed for chlorination barrels.*

The combination with a chlorination barrel or tank of a filter bed placed therein and composed of a series of bars placed side by side and having grooves in their sides forming spaces for filtering material, the corners of the bars being cut away to permit insertion of the filtering material after the bars are placed side by side, and binding strips located at the ends of the bars and covering the filling openings, the said strips being secured to the barrel to hold the filter in place, an outlet being formed in the barrel below the filter.

708494—September 2, 1902. J. Randall. *Apparatus for extracting metals from ores.*

In an apparatus for treating ores, the combination of a series of tanks with a series of agitators above said tanks and discharging into the same, so arranged that the overflow of the solvent fluid from each tank discharges into the agitator over the next adjacent tank and from thence into the latter, and means for conveying the ore from the bottom of each of said tanks into the agitator directly above the adjacent tank for discharge into the latter.

709135—September 16, 1902. J. Brown. *Ore leaching apparatus.*

An apparatus for leaching ores, comprising a tank adapted to contain water or other liquid, a conduit connected to and extending upwardly from the tank and having the plurality of chambers, a hopper disposed above the upper chamber, ball valves for controlling the discharges of the chambers and hoppers, electro-magnets disposed above the valves and adapted when energized to raise the same, the hoods and deflectors arranged in the chambers and hopper above the electro-magnets, an electro-generator, a movable commutator and circuit wires connecting the magnets generator and commutator, the said commutator being adapted to change the circuits and the condition of the magnets.

709592—September 23, 1902. D. C. Boley. *Apparatus for treating pulverized ores of gold or silver.*

The difficulty which has been experienced in treating finely divided ores by filtration with a cyanide solution is well known. In the case of battery slimes, which are produced by crushing the ore in the battery in the presence of either water or a cyanide solution, and equally in the case of the fine dust which is produced by dry crushing and which becomes a slime by the addition of moisture, the difficulty in all these arises when attempt is made to filter the material, so as to draw off the moisture, because the slimes collect upon the surface of the filter, and when this collection reaches a certain thickness the fluid will no longer pass through and the filtering surface must then be cleaned, and this difficulty begins very soon and constantly increases as the filtering proceeds. Attempt has been made to overcome this to some extent by producing a vacuum at the delivery side of the filter, and also an attempt to facilitate the filtration by creating an air pressure on the other side of the filter; and it has been attempted to prevent the collection of this impervious coating of filtrates by stirring and agitating the contents of the filter. So far there has been no organized apparatus capable of carrying on this work of filtering slimes successfully and economically, and such an organized apparatus is the object of the present invention, which consists in a revolving filter cylinder having vacuum chambers and means for supplying air pressure, the filtering surface being arranged in cylindrical form inside of the vacuum chambers, and the mode of operation being to agitate the pulverized ore by revolving the cylinder and by the pressure of compressed air and dissolving the gold and the silver in the presence of a solution of potassium cyanide and of the oxygen derived from the compressed air and the removal of the solution containing the gold and silver by filtration, assisted by the vacuum, and the continuous removal of the filtrates from the surface of the filter by their own gravity in the turning of the cylinder and the further cleaning of the filter surface by a backward blast of compressed air applied after the filtering therethrough ceases.

710462—October 7, 1902. R. D. Jackson. *Settling tank.*

In a settling tank, a distributer having downwardly extending discharge outlets for pulp and liquid, means for supplying material to said distributer, means for rotating said distributer, and means for raising said distributer while rotating, whereby the distributer rises steadily above the accumulating deposit.

710495—October 7, 1902. S. T. Muffly. *Apparatus for treating ores.*

An apparatus for treating ores, comprising a rotary cylinder, air inlet and outlet pipes connected therewith at opposite ends thereof, automatic valves oppositely directed and controlling the inlet and outlet pipes, means for forcing air through the said inlet pipe, means for heating the said air, a solvent container connected with the air inlet pipe whereby the solvent is forced by and with the air into the rotary cylinder in the form of a spray, means for governing the amount and pressure of air and of the solvent, devices within the cylinder for scattering and agitating the ores as the said cylinder is revolved.

711236—October 14, 1902. H. Smith and P. C. Brown. *Apparatus for use in extracting precious metals from their ores.*

In a lixiviation apparatus, a revoluble tank, pipes conducting a solvent, air, and steam to the tank, means for rotating the tank, and a pipe in the end of the tank opposite the end containing the supply pipe.

712968—November 4, 1902. J. J. Prindle. *Barrel filter.*

In a chlorination barrel filter, a platform comprising a series of perforated members or sections having the end portions thereof thickened or enlarged, said enlarged portions provided on their lower sides with prolonged curved faces forming supporting heels which conform to the curvature of the barrel in which the filter platform is adapted to be used, and bolts passing through said curved heels and cooperating therewith in holding the platform in place.

713694—November 18, 1902. J. P. Schuch, Jr. *Ore mixing machine.*

An ore mixing machine, comprising the following elements: An ore mixing tank, a false bottom including a strainer, means for discharging air beneath the strainer to keep the meshes thereof free from any accumulation of slime or the like, air supply pipes disposed above the strainer to effect aeration of the contents of the tank, a track carried by the upper outer portion of the tank, an agitator shaft having its upper portion polygonal in cross section, a spider having a hub engaging the said polygonal portion and carrying traveler wheels at its extremities to engage the track, agitator bars suspended from the spider, and beaters or stirrers carried by the bars, each set of beaters being disposed in break-joint order with relation to the adjacent set of beaters.

714822—December 2, 1902. J. Randall. *Settling tank or decanting vessel.*

A settling tank, consisting of a body having a vertical side and a bottom formed of slopes of different inclinations and provided with a central outlet, the said side having a cutaway portion forming an overflow lip, a launder encircling said lip and provided with a discharge spout, a baffle plate of cylindrical form connected by strips to the upper portion of said side and extending into the tank below the top and nearly to the lower edge of said side, and a pipe leading from said central outlet.

718680—January 20, 1903. B. Tully. *Barrel filter.*

A filter, comprising a rotatable barrel, provided with a lead lining, the body of the barrel being provided with apertures and the lining being perforated opposite said apertures, a lead launder arranged on the exterior of the barrel and provided with a plurality of lead branch pipes, said branch pipes at their inner ends being fitted in said apertures and connected to the lead lining about said perforations.

719273—January 27, 1903. Z. B. Stuart. *Apparatus for treating ores.*

A tank having an open top and a concave bottom formed of perforated removable plates, a removable, conical plate upwardly projecting from the center of the bottom, a perforated box under said conical plate, a layer of coarse fabric surrounding said perforated box, a filtering material under said perforated plates, a pump, a suction pipe extending from said pump to and through the mixture in said tank to a point adjacent to the upper surface of the mixture, and a discharge pipe extending from said pump to a point adjacent to the conical part in said tank, a vacuum tank, a pipe connecting said vacuum tank to said perforated box, and a suction pump connected to said vacuum tank.

719664—February 3, 1903. J. B. Heffernan. *Chlorination barrel.*

In a chlorination barrel, a parallel series of pipes having numerous small orifices through their longitudinal walls, one or more headers adapted to receiving the ends of said pipes, a valve or valves connecting said header or headers with an outside source of fluid pressure.

719756—February 3, 1903. S. C. C. Currie. *Mechanism for mixing and storing liquids and gases for ore treatment.*

In combination, an alkali mixing tank, an alkali stock tank at a lower level and connected by a pipe thereto, a mixing chamber at a level below the alkaline storage tank, said mixing chamber having inclines leading from opposite sides, a chlorin gas supply pipe leading from above the top of the mixing chamber into the bottom thereof, a storage tank for chlorinated liquid below the level of the mixing tank, and a gas supply pipe leading from the top of the mixing chamber nearly to the bottom of the storage tank.

722314—March 10, 1903. L. H. Mitchell. *Discharge means for tanks.*

A discharge apparatus for tanks, provided with a casting having an upwardly projecting rim provided with shoulders having longitudinally inclined underfaces, a funnel having a base provided with a depending offset portion, a gasket mounted in the recess formed by said offset portion and adapted to seat upon the top of the rim, lugs formed on the depending portion and provided with longitudinally curved upper faces to engage the inclined faces of the shoulders, and operating handles at the top of the funnel.

722399—March 10, 1903. H. R. Cassel. *Barrel filter.*

A barrel filter composed of a barrel having a lead lining, and of a filter having rigid cores and surrounding lead casings made integral with the lining.

725549—April 14, 1903. H. R. Ellis. *Centrifugal lixiviating machine.*

In a centrifugal filtering machine, the combination of a rotary shaft, a drum mounted thereon, a perforated partition within the drum, arranged concentrically with the periphery of the drum at such distance therefrom as to form an annular chamber about the perforated partition, means for supplying liquid to the annular chamber, a discharge opening in the bottom of the drum, a cover therefor adapted to be held open by centrifugal force when the drum is rapidly rotated to permit discharge of the charged liquid, and to be held in closed position when the drum is rotated slowly, and a discharge gate in the bottom of the drum at a point nearer the center than the discharge opening.

727230—May 5, 1903. F. G. Underwood. *Leaching tank filter.*

The apparatus consists of a tank having a central discharge aperture provided with a movable closure, an interior filter diaphragm spaced from the bottom of the tank and having a central discharge aperture registering with the tank discharge aperture and provided with a movable closure, in combination with vertical filter members radially disposed and spaced apart between said discharge apertures and the walls of the tank and communicating with the space beneath the diaphragm.

727302—May 5, 1903. H. Hirsching. *Apparatus for treating ores.*

An ore treating apparatus including a leaching vessel, a settler, a filter, a still, a condenser containing a coil, a stock solution tank, and an absorption tank, said absorption tank consisting of an outer casing communicating with a cooling water tank, an inner casing spaced from the outer casing and communicating with the stock-solution tank, and an innermost casing spaced from the inner casing and communicating with the coil of the condenser, whereby the vapors and fluid emerging from the coil are caused to flow through the innermost casing and through the absorption water, and the absorption water is caused to flow through the inner casing to the stock solution tank, said parts being connected together by means of pipes.

728126—May 12, 1903 P. W. McCaffrey. *Precipitating apparatus.*

In precipitating apparatus, the combination of a tank having curved walls, said tank being adapted to hold the solution to be treated and being provided with a central partition around the extremities of which the liquid is free to circulate, blocks or pieces made fast to the opposite sides of the tank, their inner surfaces being parallel with the surfaces of the partition, and cylinders mounted to rotate on opposite sides of the partition and partially immersed in the solution, said cylinders being perforated and containing scrap iron, the ends of the cylinders being located as close to the partition and the said blocks as is practicable in order to allow perfect freedom of movement, and means for rotating the cylinders in reverse directions whereby the liquid is set in motion in a circular current.

728746—May 19, 1903. P. W. McCaffrey. *Means for precipitating dissolved metals.*

In precipitating means, the combination of a tank adapted to hold the liquor from which the precipitation is to be made, a number of perforated cylinders containing scrap metal, said cylinders being mounted to rotate in said tank which is constructed to receive solution at one end and discharge it at the opposite end above the lowest part of the cylinders, the latter being arranged in successive order from the feed to the discharge extremity of the tank and partially immersed in the solution, and suitable means for producing a current of liquid through the tank from end to end, whereby the contact of the liquid with the scrap metal in the tanks is facilitated.

729805—June 2, 1903. J. Stoveken and L. Stoveken. *Apparatus for extracting metals from ores.*

In an apparatus for extracting precious metals from their ores, the combination of a tank for containing a cyanide or other suitable solution, means for reducing ore to a finely divided or comminuted state, one or more conduits connected with the solution tank and arranged to supply the ore with solution incident to the reduction thereof, means for agitating and mixing the ore and solution, arranged to receive the same from the reduction means, a filter arranged to receive the ore and solution from the agitating and mixing means, and adapted to separate the solution from the ore, one or more decanting tanks arranged to receive the solution or solutions from the filter, a precipitating tank which receives the clear solution from the decanting tank or tanks, and means for transferring the solution from the precipitating tank back to the solution tank.

729806—June 2, 1903. J. Stoveken and L. Stoveken. *Agitation tank.*

The combination of a tank, a central, vertical cylinder arranged therein, a piston movable in the cylinder and having a rod extending through the upper head thereof, a gear disposed above the tank and adapted to be connected by a driving connection with a motor, a shaft stepped on the piston rod and keyed to and adapted to move vertically through the gear, wings connected to and extending inwardly from the vertical wall of the tank, agitating means carried by the said shaft and surrounding the upper end of the cylinder, and comprising a head fixed on the shaft, blades disposed below the wings and connected together, said blades being curved in the direction of their length and inclined in the direction of their width, connections between the outer portions of the blades and the head on the shaft, connections between the inner portions of the blades and said shaft, and a pipe communicating with the cylinder below the piston and adapted to be connected with a source of fluid pressure supply.

730165—June 2, 1903. J. Stoveken and L. Stoveken. *Metallurgical filter.*

In an apparatus for extracting precious metals from their ores, the combination of a filter comprising a frame, an endless filter cloth, means for driving same, means for pressing pulp against the upper stretch of the cloth at different points and separate receptacles arranged below the cloth at such points, and a decanting vat having separate tanks connected with the said separate receptacles of the filter; the said separate tanks communicating with the vat at their upper ends, and having valved discharges at their lower ends.

730384—June 9, 1903. W. H. Motter. *Agitating apparatus.*

The combination of a rocking platform, means for operating the same, a frame mounted to reciprocate adjacent to the platform, cylindrical tanks or vats trunnioned on the frame and engaging the platform, flexible devices connected with the opposite extremities of the frame, guides therefor, a liquid containing tank, a piston therein, stems protruding from the opposite extremities of the tank, and a valve controlled conduit connecting the opposite extremities of the tank, the flexible devices of the frame being connected with the piston stems.

730385—June 9, 1903. P. W. McCaffrey. *Apparatus for the precipitation of metals from solutions.*

In apparatus for the precipitation of dissolved metallic values, the combination of a tank adapted to hold the solution to be treated, and a perforated receptacle containing scrap metal, the perforated walls of the said receptacle being composed entirely of the same material, said receptacle being partially immersed in said solution and mounted to rotate therein, whereby the solution is made to circulate through the scrap metal for the purpose set forth.

732720—July 7, 1903. H. Duncan and R. R. Sherriff. *Apparatus for separating liquids from solids.*

A machine for separating liquids from solids, comprising in combination a framing and gear, carrying and traversing an endless band of filter cloth, automatic slip devices for securing the band, a vacuum box or suction chamber located upon the under surface of said band, and an interposed endless band of wire cloth or gauze arranged to support and travel with the filter band.

733739—July 14, 1903. F. H. Officer, R. H. Officer, J. H. Burfeind, and J. W. Neil. *Apparatus for use in metallurgical processes.*

In an apparatus for treating ores or other materials containing gold or silver or other metals by the cyanide process, the combination of a treating tank, an absorption tank containing a caustic solution, a compressor and connections as described between the compressor, treating tank and absorption tank whereby air or gas under pressure may be forced from the compressor through the material in the treating tank and the gases released or freed from said material may be passed through the absorbing solution in the regenerator tank and thence to the compressor, so as to permit the air to be used over and over and the valuable products released in the treating tank to be recovered, as and for the purpose described.

735206—August 4, 1903. L. P. Burrows. *Mixing and dissolving apparatus.*

A mixing and dissolving apparatus, comprising a containing vessel, a shaft in and movable relatively to said vessel, an inner and an outer set of stirring plates carried by and arranged around and substantially parallel to said shaft, the adjacent plates of the inner and outer sets converging toward each other from their front to their rear edges, and stirring blades secured to the rear edges of said plates and arranged in a spiral line around the shaft, the corresponding blades of the outer and inner sets being twisted in opposite directions.

735834—August 11, 1903. L. B. Skinner. *Filter.*

A filter bar, consisting of a body portion and separated tongues projecting laterally therefrom and recessed for the passage of filtering fluid, each tongue with a beveled end, and beveled faces on the body between the tongues.

735835—August 11, 1903. L. B. Skinner. *Filter.*

The combination in a filter bed, of bars having each a body portion and a perforated side flange with a beveled edge, and a beveled face constituting the bearing of the flange of the adjacent bar.

735960—August 11, 1903. G. S. Foster and S. S. D. Stringer. *Metal-extracting and ore-lixiviating apparatus.*

The combination of a solution-supply tank, a series of intercommunicating leaching tanks adapted to receive solution from said supply tank, drainpipes leading from said leaching tanks, a launder into which said drainpipes are arranged to discharge, and a charcoal box connected to said launder.

736036—August 11, 1903. H. L. Sulman and H. F. Kirkpatrick-Picard. *Apparatus for the recovery of precious metals.*

In an apparatus for recovering precious metals, the combination of a conical vessel having an inner amalgamated copper surface, a conical body having an outer amalgamated copper surface disposed concentrically within the vessel and forming therewith a narrow interspace, a body of mercury charged with an electropositive metal in the interspace, an electrolytic vessel for charging the mercury, a mercury pump, an inlet conduit to the top of the interspace from the electrolytic vessel, an outlet conduit for mercury from the bottom of the interspace to the pump, a conduit from the pump to the electrolytic vessel, an inlet conduit at the bottom of the vessel for the solution carrying the values, a nonreturn valve in said conduit, means for forcing the solution up through the interspace, and a launder at the top of the vessel to receive the discharged solution.

736078—August 11, 1903. H. T. Durant. *Apparatus for the treatment of ores with solvents.*

A device for the treatment of ore, tailings, or other material by solvents, consisting of a tank having a conical bottom, a plug in said bottom and made conical to correspond to the angular walls thereof, a pump or forcing device discharging into the apex of the cone, and a return connection between the upper part of the tank and the suction of the pipe.

736597—August 18, 1903. C. D. Grove. *Barrel filter.*

In a barrel strainer, the combination with the shell thereof of a strainer the exterior surface of which is in contact with the barrel, its inner surface being provided with suitable straining perforations in the form of slits combined with transverse grooves beneath the interior surface and establishing communication between said slits and the discharge opening.

737046—August 25, 1903. J. B. Truitt, W. L. Truitt, and W. O. Temple. *Precipitating zinc box.*

In a precipitating zinc box, the combination of an outer imperforate box having a valved outlet in its bottom and a valved outlet above its bottom, a launder at each outlet, and an inner removable zinc holding box having a perforated bottom, and supported in the outer box above the bottom of the latter.

737553—August 25, 1903. E. L. V. Naillen. *Apparatus for extracting gold and other metals from ores.*

In an apparatus for extracting metals from ores, the combination of a concentrating tank consisting of two cone shaped sections secured together at their largest diameter by means of suitable flanges and provided with an intermediate strip secured between said flanges and projecting outwardly, a settling tank disposed around the concentrating tank, a perforated diaphragm placed between the concentrating and settling tanks and supported upon said intermediate strip, and a suitable bracket bolted to the settling tank and adapted to form two horizontal sections within the settling tank.

738148—September 8, 1903. J. B. de Alzugaray and W. A. Mercer. *Apparatus for extraction of precious metals from their ores.*

Apparatus for treating ores, consisting of a closed containing vessel or vat provided with fixed internal blades or wings, a rotating hollow spindle provided with ball bearings and having hollow blades or beaters set at an angle, means for raising and lowering the spindle in the vat, gearing for rotating the spindle, and means connected with the vat for supporting the gearing and steadying the spindle, all combined, arranged, and operating as shown and described and for the purpose set forth.

738329—September 8, 1903. W. E. Holderman. *Device for treating slimes.*

In a device for treating slimes having a liquid-tight case, a discharge pipe provided with a valve in its bottom, an inclined floor in said case, spaced bars on said floor and the sides of the case, a filtering fabric covering said bars and overlapping the upper edge of the tank, a molding to hold the fabric in operative position, and pipes provided with stoppers leading from the filter out through said case.

740163—September 29, 1903. E. D. Sloan. *Barrel filter.*

In a barrel filter, the combination with the barrel of a partial lining of porous filter blocks fitting closely together and having grooves formed on their undersides which interconnect from block to block and form drain channels; means for sealing said draining channels from the inner space of the barrel, and a discharge port leading from the drains out of the barrel.

741185—October 13, 1903. H. H. Thomson. *Apparatus for extracting precious metals.*

An apparatus for extracting precious metals, comprising a receptacle provided with an outlet, a series of bodily movable and loosely mounted agitating arms gradually decreasing in length and adapted to be retained in their operative position when rotated in one direction and to assume an inoperative position when moved in an opposite direction, a rotatable means for suspending said arms within said receptacle, said rotatable means and arms bodily movable, a series of screened nozzles communicating with said receptacle, means for supplying a cyanide solution, compressed air and water to each of said nozzles either separately or in any preferred combination, operating means for said rotatable means, and means communicating with said supply means and the said outlet for exhausting the solution from said receptacle.

741402—October 13, 1903. W. E. Holderman. *Leaching tank.*

In a filtering tank having vertical slats covered with a filtering fabric, a filtering partition extended across said tank, a trough in its bottom for the filtrate, and an orifice through the filtering fabric of said tank into which the filtrate from said trough is discharged.

741409—October 13, 1903. A. E. Johnson. *Barrel filter.*

In a barrel filter, the combination with a suitable barrel or cylinder, of a filter having a perforated bottom, side walls extending below the bottom and engaging the barrel on the inside, filtering material resting on the bottom and confined by the side walls, a top perforated plate, and suitable means for securing the filter in place, a channel being formed underneath the bottom of the filter to receive the filtered liquid, the barrel being provided with a valved outlet in communication with the said channel.

744550—November 17, 1903. J. A. Ogden. *Process of extracting metals from cyanide solutions.*

The process of treating gold, silver, or other metals from a cyanide or primary solution, consisting in mixing in a receptacle a given quantity of said primary solution with a given quantity of a secondary solution having a metal base and capable of liberating the metals in said primary solution; leaving said mixture in said vessel until said liberation is partially effected, then passing said mixture into a second receptacle and agitated therein so as to produce a complete commingling of said solutions, from thence running the mixed solution into a settling tank and allowing it to settle, drawing off the clear solution, and then drying the precipitation and pressing and melting it into bullion.

743551—November 10, 1903. J. A. OGDEN. *Apparatus for extracting precious metals from cyanide solutions.*

An apparatus for the purpose set forth, consisting of primary and secondary solution tanks, each provided with discharge pipes with controlling cocks, and measuring glasses, a mixing vessel adapted to receive the flow from said measuring glasses; a barrel, with rotatable blades therein, and having a glass gauge on the outer face thereof, and a settling tank adapted to receive the discharge from said barrel.

745472—December 1, 1903. W. H. ADAMS, JR. *Apparatus for treating ores.*

The combination of a tank, a box, a pipe at the top of the tank connecting the same with the box, a pump connected with the box, and nozzles connected with the pump and arranged to discharge liquid into the tank at intervals tangentially in an approximately horizontal plane.

746867—December 15, 1903. DE W. C. MOSHER. *Chlorination barrel.*

A chlorinating barrel provided with a resistant lining and with an arched channeled rib extending longitudinally, secured to said lining and having perforations between the interior of the rib and barrel, and a discharge opening communicating with the interior of the rib.

748088—December 29, 1903. G. MOORE. *Filtering system.*

In a filtering system, the combination with a tank for containing the material to be filtered and a cleansing fluid tank, of a filter, means for introducing and removing the same into and from each of said tanks alternately, means for drawing the contents of said tanks through the filter, and means for cleansing the filter.

748217—December 29, 1903. C. H. RIDER. *Apparatus for dissolving organic or inorganic substances.*

A device consisting of an acid tank, a water tank, an upper series of tanks connected with the acid tank and the water tank and to each other, a lower series of tanks adapted to receive the substance to be treated, connected to the upper series of tanks and to the water tank and to each other; a retort, means for heating the retort, a pipe passing from the retort through the lower series of tanks, and a condenser into which the last-named pipe extends, substantially as and for the purposes specified.

748462—December 29, 1903. W. J. ARMBRUSTER. *Chlorination barrel.*

A chlorination barrel having a pulp chamber and a chlorine generating compartment rotatable therewith, a wall separating the pulp chamber from the compartment, said wall having an unobstructed opening disposed about the axis of rotation of the barrel for freely permitting the discharge of the chlorine above the surface of the pulp in the pulp chamber.

CLASS 75—METALLURGY.

Subclass 185—Cyanides.

323222—July 28, 1885. J. W. SIMPSON. *Process of extracting gold, silver, and copper from their ores.*

The ore is crushed to a powder, treated with a solution produced by dissolving 1 pound of cyanide of potassium, 1 ounce of carbonate of ammonia, and one-half ounce of chloride of sodium in 16 quarts of water when the ore contains gold and copper only; but when it is rich in silver the quantity of chloride of sodium employed is increased. After thorough agitation of the ore in the solution the mixture is allowed to stand until the solution has become clear, when the dissolved metals are precipitated out by means of a plate of zinc suspended in the liquid. The metal is precipitated upon the zinc and can be removed by scraping or by dissolving the zinc in sulphuric or hydrochloric acid.

403202—May 14, 1889. J. S. MACARTHUR, R. W. and WM. FORREST. *Process of obtaining gold and silver from ores.*

The invention consists in subjecting finely-powdered argentiferous ores to the action of a solution containing a small quantity of a cyanide, the cyanide contents of the latter being proportioned to the quantity of gold or silver, or both, found, by assaying or otherwise, to be in the ore. Any cyanide soluble in water may be used, but in all cases the solution must be extremely dilute, since such a solution has a selective action in dissolving gold or silver in preference to the baser metals. The claim covers the use "of a cyanide solution containing cyanogen in the proportion not exceeding 8 parts of cyanogen to 1,000 parts of water."

418137—December 24, 1889. J. S. MACARTHUR, R. W. and WM. FORREST. *Process of separating gold and silver from ore.*

This invention has for its object the preventing of loss of cyanide in the case of weathered ores by first neutralizing the ore with an alkali or alkaline earth and then leaching such prepared charge with a cyanide solution. Further, the precious metal thus dissolved in the cyanide solution is precipitated out by passage through a sponge of zinc composed of fine threads or filaments of zinc formed by cutting shavings with a turning tool from a series of zinc disks held in a lathe, or by passing molten zinc at a temperature just above the melting point through a fine sieve and allowing it to fall into water.

482577—September 13, 1892. E. D. KENDALL. *Composition of matter for the extraction of gold and silver from ores.*

Consists in extracting gold and silver from minerals, "tailings," and other matters containing one or both of these metals by an aqueous solution of one or more soluble ferricyanides and one or more soluble cyanides prepared by dissolving a ferrocyanide in one portion of water and a cyanide in another portion and mixing the two solutions, or by adding either salt in solid form to the solution of the other.

492221—February 21, 1893. C. MOLDENHAUER. *Extracting gold from its ores.*

Consists in subjecting gold ores to the solvent action of cyanide of potassium in the presence of ferricyanide of potassium.

493054—March 21, 1893. W. A. G. BIRKIN. *Process of and solvent for separating precious metals from their ores.*

Covers the art of separating metals from their ores by subjecting the suitable comminuted ore to the action of a menstruum composed of potassium cyanide, potassium ferricyanide, and peroxide of hydrogen in water, and separating the values from this solution by precipitation, deposition, or electrolysis.

496950—May 9, 1893. H. PARKES and J. C. MONTGOMERIE. *Process of extracting gold or silver.*

Claims a process for extracting gold and silver from ores or compounds by an interrupted operation, consisting of treating the ore with cyanide of potassium in the presence of oxygen under pressure with agitation, the ore being subsequently filtered and washed and the precious metals recovered from the liquor by precipitation or other known means.

514157—February 6, 1894. W. P. MILLER. *Process of recovering precious metals.*

Has for its object the preservation of the cyanide solution, and consists in the treatment of the ore with the cyanide solution in air-tight vessels not only during the process of solution, but during the filtration and up to the time of the precipitation of the precious metals from the filtered solution.

522739—July 16, 1894. C. MOLDENHAUER. *Process of precipitating gold or other precious metals from their solutions.*

Dissolves gold and other precious metals from their ores by means of acid cyanide solutions, which consist in treating the solution with aluminum, so as to precipitate the gold from the solution, and then add a free alkali or alkaline earth for a regenerating solution.

524601—August 14, 1894. J. C. MONTGOMERIE. *Process of extracting gold or silver from ores.*

Sodium oxide (caustic soda) or other suitable oxide of the alkalies is added to the cyanide solution before mixing the same with the ore. After the precious metals have been dissolved in the solution and the liquid filtered off and the precious metals precipitated out, the remaining solution is tested to determine the quantities of potassium and sodium oxide still remaining in it, and any deficiency is supplied or the solution fortified by the addition of the necessary quantity of these agents, so as to restore the solvent solution to its original character and strength.

524690—August 14, 1894. E. D. KENDALL. *Method of treating gold or silver ores.*

Covers the treating of gold or silver ores with a composition of matter consisting of sodium dioxide and a suitable cyanide in solution.

532238—January 8, 1895. C. MOLDENHAUER. *Method of precipitating precious metals from solutions.*

Consists in subjecting the ores to the action of an acid cyanide solution so as to dissolve the gold or other precious metal contained in them, then adding aluminum so as to precipitate the gold or other metal from the solution, and then regenerating the cyanide solution by means of a free alkali or alkaline earth.

532895—January 22, 1895. J. C. MONTGOMERIE. *Process of extracting gold or silver from ores.*

Consists in adding an oxide or one of the alkaline bases to a cyanide solution, then mixing with the ore or compound the solution thus rendered alkaline, then conducting the process under pressure of oxygen, and afterwards separating from the ore the liquid containing the gold and silver in solution, then treating that liquid in any approved way for the recovery of the precious metal.

538951—May 7, 1895. S. C. CLARK. *Process of treating refractory ores.*

Claims the process of treating a refractory ore, consisting essentially in boiling the ore in water containing from 10 to 15 pounds of cyanide of potassium to each ton of ore for about one hour or for a sufficient length of time to enable the cyanide of potassium to dissolve the chloride, sulphide, or bromide in the ore, then allowing the solution to settle and finally evaporating the clear liquid so as to obtain a residue containing metal.

540359—June 4, 1895. G. KENNAN. *Process of and apparatus for treating ores.*

Claims the process of treating the ores of gold and silver, consisting in subjecting the same to the action of cyanide of potassium, agitating the same for a short period of time, discontinuing the agitation, and bringing air in contact therewith, the oxygen thereof increasing the action of the cyanide, continuing the agitation for a few minutes, until every particle of ore has been brought in contact with the cyanide solution in the presence of atmospheric air, and withdrawing the solution from the remaining pulp or ore.

541833—June 18, 1895. F. RINDER. *Process of separating gold and silver.*

Consists in the treatment of cyanide solutions containing gold and silver with sulphide of iron to precipitate the silver and then with chloride of zinc to precipitate the gold.

543543—July 30, 1895. M. E. WALDSTEIN. *Process of extracting gold or silver from ores.*

Consists in subjecting the ores to the action of cyanide of potassium, adding to the material during this action a salt or salts (such as binoxide of barium) decomposable by an acid and yielding oxygen, and sufficient acid to decompose this salt or salts, and subsequently adding an excessive acid to decompose the soluble cyanide and finally separating the precious metals as sulphides by precipitation with sulphureted hydrogen or by a soluble sulphide.

543672—July 30, 1895. M. CRAWFORD. *Process of extracting precious metals from their ores.*

Consists first in lixiviating the ores of the precious metals with a cyanide solution to which has been added a substantially neutral substance which contains a permanent excess of oxygen; second, in subjecting the gangue and accompanying cyanide solution to an amalgamating process; and, thirdly, in withdrawing the solution from the tailings, and extracting the precious metals therefrom. The neutral substance containing a permanent excess of oxygen may be prepared by mixing peroxide of sodium with dilute sulphuric acid and neutralizing with silicate of soda.

543676—July 30, 1895. M. CRAWFORD. *Process of extracting precious metals from their ores.*

Consists in, first, lixiviating the ore with a cyanide solution to which has been added a small quantity of a substance prepared by agitating ether with binoxide of barium and adding thereto small quantities of very dilute hydrochloric acid, and neutralizing by silicate of soda, and, second, separating the precious metal from this solution in which the ore has been lixiviated.

545852—September 3, 1895. P. DE WILDE. *Method of extracting gold.*

The precipitation of gold in the form of a mixture of aurous cyanide and cuprous cyanide by acidulating a cyanide solution containing the gold with an acid sulphurous compound and afterwards adding a solution of copper salt. Also, specifications provide for the dissolving of gold by the use of a weak solution of potassium or sodium cyanide which has been in contact with the minimum or protoxide of lead, and for the recovery and utilization of the spent cyanide by its conversion to Prussian blue.

547796—October 15, 1895. J. J. HOOD. *Extracting metals.*

The method for the extraction of precious metals from their ores, which consists in treating the ore with a solution containing both a cyanide of potassium or sodium and a salt or compound of a baser metal in the proportion of one part at least of the former to two parts of the latter; the metallic base of the solution being displaced by the precious metal, the former being precipitated. The gold is then precipitated out by a copper-zinc couple. By "baser metal" is meant mercury, lead, and such other metals as are displaced by metallic gold from their solutions in alkaline cyanides. A mixture that answers well consists of two parts, by weight, of cyanide of potassium (or its equivalent of cyanide of sodium), one part of mercuric chloride or its equivalent of sulphate or other mercury salt, and from one-half to two parts of caustic soda.

549736—November 12, 1895. J. C. MONTGOMERIE. *Extraction of gold and silver from ores.*

The improved process of extracting gold and silver from ores or compounds containing the same, consisting in treating the ore in a vessel containing water with a cyanide, an alkaline oxide, a nitrate, and an oxidizing agent. Sodium dioxide may be taken as a representative of the alkaline oxide and aid under pressure as an oxidizing agent, as set forth in this claim.

555463—February 25, 1896. J. S. MACARTHUR and C. J. ELLIS. *Process of extracting gold and silver from ores.*

Consists in subjecting the ore to the action of a cyanide solution and precipitating, by means of a metallic compound capable of combining with sulphur, any sulphur which may become soluble in the solution and thereby rendering it inert. Salts or compounds of lead, manganese, zinc, mercury, and iron are types of the metallic compound employed. By means of a salt of lead any copper present in the cyanide solution may be precipitated out.

555483—February 25, 1896. T. L. Wiswall and J. B. Frank. *Process of recovering precious metals from solutions.*

The process of extracting precious metals from solutions by causing said solutions to flow through a precipitating alloy, subdivided into a mass of hardened filaments, and composed of zinc, lead, and one or more other metals which impart to said filaments a tensile strength sufficient to withstand the compression of the flowing solution, such as arsenic, antimony, cadmium, or bismuth, and in which alloy there is present not more than 97 per cent of zinc.

576173—February 2, 1897. H. L. Sulman. *Process of precipitating precious metals from their solutions.*

Consists in purifying zinc fumes or dust of oxides by intimately mixing with the same an ammoniacal substance, and then mixing a quantity of said fumes or dust so purified with the solution. The apparatus by which to perform the process and for the treatment of the ores is also claimed.

578089—March 2, 1897. J. F. Webb. *Process of extracting gold and silver from ores.*

The process or method for the extraction of gold and silver from their crushed ores, consisting in saturating the ores in a solvent solution of potassium cyanide, then applying a current of compressed air from beneath and maintaining the same throughout the leaching process, then shutting off the current, then applying a current of compressed air on top of the solution after the ore containing vat has been closed at top and a drain at the bottom has been opened, and maintaining the same until the solution has been driven out of the ore, then shutting off the current of air, then admitting water to the vat, then introducing a compressed air current at the bottom of the vat, and finally introducing a current of compressed air on top after the vat has been again closed at top and a drain opened at bottom.

578178—March 2, 1897. D. White and T. M. Simpson. *Process of and apparatus for extracting precious metals from slimes, etc.*

In the extracting of precious metals from slimes and other auriferous and argentiferous materials, the process which consists in mixing the said material with a cyanide solution in a closed vessel, then agitating the mixture by passing a gas under pressure through the same, then passing gas under pressure, together with the gases arising from the action of the cyanide solution in the said material, through another quantity of said material and cyanide solution in a closed vessel, then conveying the gases back to the source of compression and drawing off the solution containing the precious metal and extracting said metal. The apparatus for accomplishing this purpose is also claimed.

578340—March 9, 1897. W. A. Koneman. *Process of extracting precious metals from their ores.*

The process of extracting precious metal from the ore containing it, which consists in wetting the ore, in a pulverized condition, with just sufficient cyanogen-containing solution to moisten the ore and reduce the mass to the condition of mud, maintaining the saturated ore in a quiescent state for a prolonged period of time, then diluting the mass and subjecting it to agitation for a suitable period of time, separating the resultant solution from the ore by filtration, and finally precipitating the precious metal from said solution.

578341—March 9, 1897. W. A. Koneman. *Process of recovering precious metals from cyanide solutions containing them.*

The process of recovering, by precipitation, the precious metal or metals contained in a cyanogen-containing solution, which consists in subjecting said solution to contact with an alloy composed of lead and zinc, and in which lead is the preponderating metal in weight, or with an alloy composed of lead, zinc, and aluminum.

580688—April 13, 1897. C. W. H. Göpner and H. L. Diehl. *Recovery of gold and silver from their solutions.*

The process for the precipitation of gold and silver from their cyanide solutions, which consists in adding to said solutions a considerable quantity of cuprous cyanide, then adding an acid to effect precipitation, dissolving the latter by a fresh quantity of the cyanide solution obtained by leaching, and then adding acid to effect successive precipitations from said solution.

580948—April 20, 1897. J. C. Montgomerie. *Process of treating cyanide solutions.*

The process for the extraction of the precious metals from cyanide solutions, which consists in filtering the solution through a charcoal filter, heating the filtering material on the same becoming surcharged with cyanogen or its compounds, condensing the resultant gases and obtaining ammonium cyanide and other ammonium salts in solution, applying the regenerated charcoal (still containing the precious metals) in the filtration of a further charge or charges of the solution, and ultimately recovering from the charcoal the precious metals accumulated therein.

587179—July 27, 1897. J. H. Burfeind. *Treatment of gold and silver ores.*

As an improvement in the extracting of precious metals from their ores, the treatment of the cyanide product or precipitate containing said metals, preparatory to melting the said product with sulphurous acid.

591753—October 12, 1897. E. J. Fraser. *Process of obtaining precious metals by solution.*

The process of treating gold and silver ores by solution, which consists in converting the metal bases of dioxides of the alkaline metals into sulphates, by the addition of sulphuric acid, so as to produce hydrogen dioxide, preventing the decomposition of the hydrogen dioxide by an excess of acid, separating the solution from the metallic sulphate, mixing the solution with a solution of cyanide of potassium and lime in the presence of a precious metal, and leaching the liquid holding the precious metal.

592153—October 19, 1897. J. S. MacArthur. *Precipitating precious metals from solutions.*

The process of precipitating a precious metal from a cyanide solution, which consists in subjecting said solution containing a base metal to the action of a precipitant protected by a metal inert in said solution. Such a precipitant is found in zinc, mercury, or copper protected by lead. When copper is present in the cyanide solution, this copper is removed by the precipitant prior to the removal of the precious metal.

601201—March 22, 1898. S. Newhouse, A. J. Bettles, and T. Weir. *Method or process of extracting precious metals from their ores.*

A method or process for the extraction of the precious metals from their ores, said method or process consisting, first, in neutralizing the acidity of the ore where this condition exists; second, in placing the ore in a suitable solution of cyanide of potassium and subjecting the mass to agitation; third, in adding a quantity of zinc to the mixture of ore and cyanide and subjecting the mass to further agitation; and fourth, in adding quicksilver or mercury charged with sodium amalgam, and finally agitating the entire mass for purposes of amalgamation.

607719—July 19, 1898. M. E. Waldstein. *Process of recovering precious metals from their solutions.*

The process for extracting and recovering precious metals from their ores, which consists essentially of the following steps: First, subjecting the ore in a powdered state to the action of an aqueous solution of a cyanide; second, supplying to the solution charged with the precious metals that quantity of zinc dust determined to be exactly sufficient to precipitate said metals; third, agitating said solution and said zinc dust until said metals are precipitated and said zinc dust is absorbed; fourth, recovering the precious metals from the valuable precipitate of the preceding step by filtration, or other process.

610616—September 13, 1898. H. L. Sulman and F. L. Teed. *Extraction of precious metals from their ores.*

The essence of this invention consists in the employment of haloid compounds of cyanogen in combination with free cyanide of potassium or other suitable cyanide of the alkalies or alkaline earths as a solvent for precious metals in their ores, examples of such haloid compounds of cyanogen being found in cyanogen chloride, or bromide or iodide.

620106—February 28, 1899. W. A. Caldecott. *Method of extracting gold from cyanide.*

An improved method for the precipitation of gold from gold bearing cyanide solutions by passing such solutions over zinc shavings previously treated with a soluble salt of mercury, such as perchloride of mercury ($HgCl_2$).

624040—May 2, 1899. C. B. Jacobs. *Process of reducing metals from their solutions.*

The process of reducing metals from their solutions, consisting in subjecting them to the action of gaseous phosphide of hydrogen in the presence of an alkaline material, thereby precipitating the noble metals in a metallic state and the base metals as phosphides, and then separating the latter from the noble metals.

625594—May 23, 1899. E. D. Kendall. *Process of treating gold or silver ores and composition of matter for same purpose.*

A composition of matter to be used for extracting precious metals from ores, tailings, or other bodies, consisting of a suitable thiocyanate and a suitable ferrocyanide in watery solution.

625595—May 23, 1899. E. D. Kendall. *Process of treating gold or silver ores and composition of matter for same purpose.*

A composition of matter to be used for the extraction of precious metals from ores, tailings, or other bodies, consisting of a suitable thiocyanate and hydrogen dioxide in watery solution.

629905—August 1, 1899. J. J. Hood. *Process of extracting gold or silver.*

The process of extracting gold, silver, and mercury from solutions by bringing the solutions into contact with an alloy of zinc, antimony, and mercury, from time to time distilling off mercury from the alloy, and finally recovering the gold and silver from it. The precipitant used consists of an alloy of about one hundred parts of zinc, five parts of antimony, and twenty parts of mercury.

630988—August 15, 1899. W. Kemmis-Betty and B. Searle. *Process of recovering gold from pulp, slimes, or similar substances.*

The process of extracting gold from ores, which consists of the following steps: First, dissolving the gold in the pulp in a weak solution of cyanide of potassium; second, adding a stronger solution of cyanide of potassium to the gold-bearing solution in the proportions specified; third, immediately after so strengthening the solution, passing the same through a body of zinc shavings coated with lead.

635199—October 17, 1899. J. Smith. *Process of treating gold or silver ores.*

The process for treating gold and silver ores, tailings, slimes, and like materials containing precious metals, which consists in mixing the material to be treated with caustic lime, saturating or covering the mixture entirely with water and keeping it thus until all the acid present has combined with the lime, drying the material, exposing it to the action of atmospheric air, and treating it with a cyanide.

636114—October 31, 1899. J. S. Cain, A. Soderling, and S. M. MacKnight. *Preliminary treatment of ores or tailings before cyaniding.*

The method or process of treating ores containing the precious metals, which consists in first leaching said ores or tailings in a weak solution of nitric acid, or of nitric and sulphuric acids, subsequently leaching the same in an alkaline solution, and finally leaching the same in a cyanide solution.

636288—November 7, 1899. H. de Raasloff. *Process of extracting precious metals from ores.*

The improvement in the process of separating precious metals from their ores, consisting in mixing with the ore a solution consisting of a base and a solvent for precious metals, which solvent is capable of being separated from the said base by oxygen, and adding liquid air to the ore and solution, or by evaporating the nitrogen from liquid air, and adding the oxygen which remains to the mixed ore and solution.

638872—December 5, 1899. M. B. Zerener. *Precipitation of precious metals from their cyanide solutions.*

The process of precipitating gold and silver from cyanide solutions by causing the solution to move in one direction, and during such movement passing through it, in the opposite direction and in the form of a spray, or a number of fine streams or films, mercury charged with alkali metal.

641818—January 23, 1900. C. Whitehead. *Process of extracting gold from ores.*

The process of extracting gold from ores in which the particles of free gold are enveloped in a compound of a base metal having the following characteristics, to wit; nonsiliceous, oxidized, practically impervious to a solvent solution, such as one of cyanide, not readily removable by washing with water, and insoluble in water, but soluble in dilute acids, consisting in first subjecting the crushed ore to the action of heat sufficient to convert the coating into a porous condition and afterwards treating the ore with a cyanide solution.

642767—February 6, 1900. G. Thurnauer. *Process of separating precious metals from their mixtures with zinc.*

The process of treating the mixture of zinc and precious metals resulting from the treatment of cyanide solutions of the precious metals by zinc, which consists in subjecting said mixture to the action of a solution containing lead and then to the action of acid, whereby the zinc is dissolved and the precious metals remain in admixture with metallic lead.

646006—March 27, 1900. J. C. Montgomerie and H. Parkes. *Treatment of gold and silver ores, etc.*

In the extraction of gold and silver from ores or compounds containing the same, the process consisting in treating the ore or compound with a cyanide of an alkali metal, caustic alkali, and barium dioxide, in conjunction with ammonium sulphate.

646808—April 3, 1900. T. Cruse. *Method of extracting gold and silver from their ores.*

The process of recovering precious metals from their ores, which consists in first heating the ore pulp to the boiling point, adding cyanide of potassium to the hot mass, permitting the mass to gradually cool, and while it is cooling adding to the mass the following: Bluestone, iron sulphate, sulphuric acid, and quicksilver.

649628—May 15, 1900. W. A. Caldecott. *Extraction of gold or other precious metals from slimes.*

The method of extracting precious metals from finely divided materials, such as slimes, containing reducing substances, such as ferrous sulphide or hydrate, which consists in rendering the material alkaline, then forcing air into the pulp until the ferrous compounds are converted into ferric hydrate, then adding cyanide and continuing aeration and agitation until the precious metals are dissolved.

651509—June 12, 1900. F. W. Martino and F. Stubbs. *Precipitation of precious metals from cyanide solutions.*

A process for the precipitation of the precious metals from their aqueous cyanide solutions, consisting in passing acetylene and atmospheric air through such solutions, or by adding calcium carbide to them, and precipitating the metals in a metallic state.

651510—June 12, 1900. F. W. Martino and F. Stubbs. *Treatment of ores and precipitation of precious metals from their cyanide solutions.*

A process for the precipitation of precious metals from their aqueous cyanide solutions, consisting in treating such solutions with a hydrocarbon gas, produced when a metallic carbide is decomposed by water, and capable of precipitating the metals in a metallic state. Aluminum carbide is given as an example of such a metallic carbide. The use of methane as a precipitant is also claimed.

657181—September 4, 1900. H. de Raasloff. *Process of separating precious metals from their ores.*

The continuous process of treating ores of precious metals, consisting in mixing the finely divided ore with a suitable solvent for the precious metals, inducing the mixture to flow continuously from and back to the point of admixture, while so flowing introducing liquid oxygen or liquefied air into the mixture, then causing the mixture to flow with sudden variations of velocity to agitate it, then separating the solution from the base earthy mineral matter, and sending it continuously through an electro-depositing bath, where the precious metal is deposited, and thus in continuous ordered succession.

656395—August 21, 1900. E. H. Dickie. *Process of leaching ores or tailings.*

The improvement in the process of leaching ores or tailings with a solution which dissolves the precious metals, which consists in adding to the solution an agent composed of an acetate of an alkali metal or of alkali earth metals which is capable of readily uniting with and forming acetates of the base metals, and which has little or no affinity for the precious metals, thereby enabling the solvent to act directly upon the latter, and then leaching the ores. Calcium acetate is cited as an example of an acetate of an alkali-earth metal.

664060—December 18, 1900. J. P. Schuch, Jr. *Process of extracting precious metals from their ores.*

A method of extracting precious metals from their ores, which consists in combining the crushed ore with a cyanide solution while both are in a warm condition, mechanically mixing the ore and solution by agitation simultaneously with the commingling thereof, charging the mixture during the agitation with hot air, and finally separating the ore and slush or pulp from the metal in solution.

665105—January 1, 1901. J. C. Kessler. *Process of extracting gold and silver from ores.*

The process of separating precious metals from auriferous and argentiferous ores, consisting, first, in subjecting the ores to the action of an aqueous solution, consisting of cyanide of alkali metal, yellow prussiate of potassium and permanganate of an alkali metal in substantially the proportions of water, one thousand (1,000) parts; yellow prussiate of potassium, two and one-half (2.5) parts; cyanide of alkali, two and one-half (2.5) parts; permanganate of potassium, one-tenth (0.1) part, until the gold and silver contained in such ores are dissolved; second, separating the metals from their solution by the application of a soluble lead salt, by which the cyanide solution is decomposed and a nonsoluble cyanide of lead is formed, at the same time a nonsoluble cyanide of gold or silver is precipitated; third, by the application, to the sediment thus precipitated, of sodium amalgam, whereby a gold, silver, and lead amalgam is produced and at the same time a concentrated solution of cyanide and ferrocyanide of sodium is regenerated; and fourth, diluting the concentrated cyanide solution with a quantity of water and regenerating and reenergizing the aqueous solution for reuse by the addition of permanganate of alkali.

671704—April 9, 1901. E. D. Kendall. *Process of treating ores containing silver or silver and gold.*

The process of treating ores or other bodies for the extraction of precious metals, which consists in treating them with a suitable chemical solution containing a thiocyanate and a cyanide, capable of dissolving silver or silver and gold, and in then treating the so-dissolved silver by a suitable sulphide, such as potassium sulphide, and in so regulating the amount of the sulphide to the silver as that they shall substantially equalize each other in separating the sulphur sulphide and in returning the thiocyanate and cyanide into subsequent operations for further treatment of the ore.

673425—May 7, 1901. G. A. Duncan and F. H. Beach. *Method of treating precious metal bearing ores.*

The method of treatment of precious metal bearing ores to cause the precious metal to be dissolved from the ore, and the resulting metal bearing liquor and impoverished ore to be separated from each other, which consists in the following steps: First, maintaining a substantially continuous supply stream of mingled comminuted ore and solvent liquor; second, mechanically dispersing such mingled ore and liquor into the air, in a direction transverse to the onward movement of the stream, without separating the ore from the liquor; third, delivering the resultant stream of mingled metal bearing liquor and impoverished ore and receiving the same in mingled condition and carrying it onward; fourth, sucking the liquor from the tailings; fifth, delivering water to the impoverished tailings remaining, and subsequently sucking such wash water therefrom; sixth, delivering such impoverished ore or tailings after the application of such suction.

682612—September 17, 1901. E. L. Godbe. *Method of leaching ores.*

The method of leaching ores, which consists in disposing moistened ore in superimposed strata within a containing receptacle by a continuous mechanical agitation in the lower portion of the latter to form a lower thoroughly agitated stratum of heavier portions of the ore, a stratum of lighter portions or particles next above which are agitated to a less degree, a stratum of slimes and other lighter particles next above which remain substantially immobile, and a top covering of a clear supernatant solution, introducing the ore below the upper surface of said latter solution, overflowing and carrying off the clear solution, replacing water in the charge by a cyanide of potassium solution introduced at the bottom of the receptacle below the lower heavier stratum and causing it to percolate upwardly through the strata above, increasing the agitation during the introduction of said cyanide solution, carrying off the metal bearing cyanide solution which overflows from the top of the charge and precipitating the said overflow metal bearing solution after it leaves the receptacle.

689190—December 17, 1901. B. Hunt. *Process of precipitating and recovering precious metals from their solutions.*

The process of precipitating precious metals, consisting of adding to the pulp a cyanide solution and agitating the same until the metal is extracted; then adding to the pulp, while continuing the agitation thereof, powdered metallic aluminum whereby the precious metal is precipitated, but in suspension in the pulp; then adding mercury and continuing the agitation until the metal is in the form of an amalgam, and finally recovering the precious metal by treating the amalgam.

692634—February 4, 1902. H. Davis. *Process of extracting precious metals from their ores.*

A process for the extraction of the precious and other metals from ore, ore pulp, sands, slimes, tailings, mineral bearing earths or other substances containing these metals, which consists in introducing chlorin gas into the ore and afterwards wholly or partially removing the excess of chlorin by forcing air into the material and afterwards treating with a cyanide solution to dissolve the chlorides.

694521—March 4, 1902. B. W. Begeer. *Cyanide process of extracting precious metals from ores.*

The process of treating material containing the precious metals, consisting in setting in motion in an endless path a solution of cyanide of potassium, introducing oxygen to the moving liquid, and finally subjecting the metal bearing material to the action of said solution.

696274—March 25, 1902. E. Schulz. *Cyanide process of extracting precious metals from their ores.*

An improved process in the art of extracting precious metals from their ores, said process consisting in thoroughly and intimately mixing peroxide of barium (BaO_2) with precious metal bearing material, and then subjecting the same to treatment with an alkaline cyanide solution.

701002—May 27, 1902. J. B. de Alzugaray. *Method of extracting precious metals from their ores.*

The process for treating ores containing precious metals and consisting in adding the crushed ore to a solution of sodium chloride, sodium carbonate, and potassium cyanide, then forcing through the mass a gaseous mixture of bromine and air and recovering the precious metals from the solution by any known means, such as electrolysis.

702805—June 10, 1902. E. D. Kendall. *Process of extracting precious metals from their ores.*

The process of treating ores carrying precious metals, which consists in treating such ore with a lixiviating solution, consisting of a cyanide, potassium percarbonate, and water, and finally extracting the precious metal from such lixivium.

705698—July 29, 1902. R. H. Officer, J. W. Neil, J. H. Burfeind, and F. H. Officer. *Cyanide process of working gold, silver, or other ores.*

The improvement in treating ores by the cyanide process, consisting in agitating the pulp containing the cyanide solution by a suitable gas under pressure, passing the gas and the hydrocyanic-acid gas liberated from the solution through a regenerating solution, and using the gas after passing through said regenerating solution to agitate a fresh quantity of pulp.

706308—August 5, 1902. L. B. Darling. *Process of extracting precious metals from ores.*

The process of extracting precious metals from finely divided materials or ores, which consists in spreading a comparatively thin layer of the material over a substantially flat and large working surface provided with drainage ducts or channels; then covering said material with suitable metal dissolving or cyanide solution; then passing a heavy roll back and forth over the charge of material, etc., thereby at the same time thoroughly agitating or stirring the charge and forcing some of the solution into the drainage ducts; then discharging said solution into the sump, and finally precipitating the precious metal from the solution.

707926—August 26, 1902. W. Hilt and C. E. Lane. *Process of extracting precious metals.*

The process of extracting precious metals from solutions thereof, which consists in producing cyanide solutions of said metals, vaporizing metallic zinc by means of heat, and conducting the vapor thus formed to a point beneath the surfaces of said solutions, thus producing finely divided zinc, which replaces the precious metals and thereby causes their precipitation.

708504—September 2, 1902. H. L. Sulman and H. F. Kirkpatrick-Picard. *Treatment of ore slimes.*

The process of treating ore slimes, which consists in separating, by means of a centrifugal machine, the ore slimes from the residual water with which they are mixed by adding a little lime to the charge, removing the bulk of the water, thereafter introducing into the machine an amount of leaching solution of a volume equal to that of the remaining quantity of adhering moisture and introduced into the slimes by centrifugal action, and replacing the moisture by the added leaching solution.

710486—October 7, 1902. S. T. Muffly. *Process of treating ores.*

The process of treating ores, which consists in injecting into said ores, as they are agitated and elevated and allowed to fall by gravity in a closed chamber, a chemical solution in the form of a spray, together with hot air under pressure, and allowing the elements and fumes freed by this operation to escape from said chamber.

718633—January 20, 1903. T. B. Joseph. *Gold extracting process.*

The process of extracting gold or silver from ore containing the same, when in a suitable condition, which consists in subjecting the said ore to the leaching action of a solution of water, cyanide of potassium, hydrate of calcium, and carbonic-acid gas, and introducing an oxidizing agent into the solution, and subsequently precipitating the gold from this solution.

719274—January 27, 1903. Z. B. Stuart. *Process of extracting metals from ores.*

The process of extracting precious metals from ore, consisting in agitating the pulp together with cyanide, water, and air by ebullition in one vessel, causing the mixture to assume an even consistency throughout, and passing the mixture through a mechanical agitator and combining therein a relatively smaller quantity of mixture with a relatively larger quantity of air and there forcing the pulp, cyanide, water, and air into intimate contact, and circulating the mixture through the two vessels.

722455—March 10, 1903. August Pfister. *Process of precipitating gold from cyanide solutions.*

The process for the precipitation of gold or other precious metals from cyanide solutions, such as potassium cyanide, sodium cyanide, and bromine cyanide, which consists in acidifying the solution, adding a solution containing salts of mercury and copper, and then adding a solution containing zinc salts and a small percentage of a potassium ferrocyanide, or a small quantity of the cyanide solution discharged from the ordinary zinc-precipitation boxes.

722764—March 17, 1903. J. P. Schuch, Jr. *Process of separating precious metals from solvent solutions.*

The process of separating precious metals from their solvent solutions, which consists, first, in passing the solution through crushed limestone or phonolite to neutralize any free acid, then through zinc, wood ashes, asbestos wool or its equivalent, and charcoal or coke, to neutralize any free soda or carbonates, then through zinc shavings to precipitate the precious metals, then through charcoal to filter the solution and effect retention of a percentage of the precious metals, then through limestone or crushed phonolite to effect precipitation of zinc contained in the solution, and then alternately through zinc, charcoal, or coke and zinc to effect complete separation of the precious metals and thorough filtration of the solution.

725895—April 21, 1903. M. V. Uslar and G. Erlwein. *Process of extracting gold.*

The process for extracting gold from auriferous ores, which consists in lixiviating the ores with a solution of potassium cyanide, rhodanides, hyposulphites, and sodium chloride.

726391—April 28, 1903. F. J. Hoyt. *Method of extracting gold from ores.*

The method of milling gold ore, consisting of the following steps: First, pulverizing the ore; second, distributing the ore thinly over a wide, long, and open sluiceway; third, flowing the ore and propelling it forward over its bed by the action of a stream of chemical solution adapted to dissolve the ore; fourth, automatically screening and separating the solution from the tailings by the same force; and fifth, subjecting the solution to a reagent to precipitate the gold therein.

727659—May 12, 1903. F. W. Martino. *Method of extracting noble metals.*

The process of recovering gold from its cyanide solution, consisting in acidifying the solution and treating it at a raised temperature with barium-sulpho-carbide. The latter is manufactured by fusing two parts, by weight, of barium sulphate (baryta or heavy spar) $BaSO_4$ in an electric furnace with one part of carbon.

728527—May 19, 1903. T. B. Joseph. *Gold extracting process.*

The process of extracting gold and silver from ore containing the same when in a suitable condition, which consists in subjecting the said ore to the leaching action of a solution of water, cyanide of potassium, hydrate of calcium, peroxide of barium and carbonic acid gas, the ore being agitated by compressed air.

730835—June 9, 1903. D. Mosher. *Ammonia cyanide process of treating copper, nickel, or zinc ores containing precious metals.*

The process of treating refractory sulphur, tellurium, and arsenical ores containing copper, zinc, nickel, gold, and silver, consisting in first roasting such ores at a low red heat to transform the metals so transformable into sulphates, arsenates, or tellurates; then oxidizing reducing compounds by very dilute ammonia; and subsequently extracting the metals with an ammoniacal cyanide solution containing an excess of cupric oxide or hydroxide over and above that necessary to form metallic cyanide double salts.

731169—June 16, 1903. O. A. Ellis. *Apparatus for extracting metals from ores.*

An apparatus for extracting metals from ores, having in combination a receiving hopper having an inclined bottom, a discharge opening in said hopper, and inclined chute leading from said hopper and provided with a screen, a precipitating box connected with said inclined chute, means for causing a flow of chemical solution through said hopper, chute, and precipitating box and means for passing a current of electricity through said precipitating box.

731681—June 23, 1903. J. T. Terry, Jr. *Extracting gold or silver from slimes.*

An improvement in separating precious metals from slimes with which they are mixed, consisting in forming a solution with water, spraying said solution into tanks containing a cyanide solution made dense by the addition of salt, allowing the slime to settle through and into the solution, then drawing the clear liquor from the top through vertically disposed filters and discharging the sludge from the bottom into succeeding tanks containing a similar cyanide solution, allowing it to settle and again drawing off the clear liquor

731839—June 23, 1903. G. A. Bahn. *Sulphuric acid process of extracting precious metals from solutions.*

The process of precipitating precious metals from solutions thereof, which consists in producing cyanide solutions of said precious metals, then acidulating with sulphuric acid said cyanide solutions, then immersing zinc in sheet, plate, or other form in the acidulated cyanide solution containing the precious metals; the chemical action thereupon taking place in the solution, dissolving zinc and precipitating the precious metals, then recovering from the precipitate of the preceding operation the precious metals by filtering and melting, or other process.

732605—June 30, 1903. G. E. Thede. *Process of leaching ores.*

The process of leaching ores which consists in mixing with the ore to be treated a cyanide solution, peroxide of hydrogen, and an oxide which is reducible by said peroxide of hydrogen.

732639—June 30, 1903. T. B. Joseph. *Gold extracting process.*

The process of extracting gold and silver from ore containing the same, when in a suitable condition, which consists in subjecting said ore to the leaching action of a solution containing water, cyanide of potassium, bromine, hydrate of calcium, peroxide of barium, and carbon dioxide, said carbon dioxide being forced into the leaching solution simultaneously with compressed air.

738758—September 15, 1903. J. B. de Alzugaray. *Extraction of precious metals from their ores.*

The process for extracting precious metals from their ores, consisting in first moistening the crushed ore with an alkaline solution and afterwards agitating it in a solvent solution and blowing through it an oxidizing agent composed of gaseous bromine and its acid and oxyacid compounds dissolved in air and finally recovering the metals from the solvent in any well-known manner.

745480—December 1, 1903. T. J. Grier. *Process of extracting precious metals.*

The process of extracting precious metals from slimes, consisting in directing the slimes into a settling tank, drawing off the thicker portions of the slimes and depositing the same into a leaching vat, of introducing a cyanide solution under pressure through perforations in the false bottom of the vat, causing the watery portions of the slimes to be displaced by said cyanide solution, then treating the charge with an air under pressure, and afterwards introducing through the false bottom of the vat a salt solution of greater density than the cyanide solution to displace the latter.

745828—December 1, 1903. E. B. Hack. *Process of extracting metals from ores.*

A cyanide process, consisting of the following steps in the order named: caking the pulp by pressure under conditions allowing the moisture to escape, introducing a weak solution of the solvent simultaneously with the introduction of air under pressure; drying the pulp by passing air under pressure therethrough; introducing a stronger solution of the solvent simultaneously with the introduction of air under pressure; and finally drying the cake by air pressure.

755651—March 29, 1904. J. Smith. *Process of treating ores.*

In the cyanide treatment of ores, the method of rendering insoluble in the cyanide solution ferrous oxide contained in a mass of moist crushed ore, which method consists in applying heat to said mass in the presence of air, previous to its treatment by the cyanide solution.

CLASS 204—ELECTROLYSIS.

Subclass 15—Aqueous Bath, Ores.

61866—February 5, 1867. J. H. Rae. *Improved mode of treating auriferous and argentiferous ores.*

This invention consists in treating auriferous and argentiferous ores with a current of electricity or galvanism for the purpose of separating the precious metals from the gangue. In connection with the electric current suitable liquids or chemical preparations, such, for instance, as cyanide of potassium, are used, in such a manner that by the combined action of the electricity and of the chemicals, the metal contained in the ore is first reduced to a state of solution and afterwards collected and deposited in a pure state.

Among the claims is one for the use of the platinum agitator as an electrode.

62776—March 12, 1867. J. H. Rae. *Improved mode of collecting gold and silver from sweepings, washings, etc.*

This invention consists in treating sweepings, filings, and washings containing gold or silver with a current of electricity or galvanism for the purpose of separating the precious metals from the impurities of foreign matter mixed with them. In connection with the electric current suitable liquids or chemical preparations, such, for instance, as cyanide of potassium, are used in such a manner that by the combined action of the electricity and chemicals the precious metals contained in the sweepings, filings, and washings are first reduced to a state of solution, and afterwards collected and deposited either as oxides or in a metallic state, and the operation of extracting or separating said precious metals from the sweepings, filings, or washings is attended with very little trouble and expense. During this operation the bath which contains the washings, filings, or sweepings acts as an electrode, and also as an agitator; and the third claim of the patent covers the use of this carbon electrode as an agitator.

90565—May 25, 1869. W. J. Lynd. *Improved process of separating iron and other metals from potters' clay.*

The process of removing iron, copper, and other discoloring matters from potters' clay and other argillaceous substances by subjecting the clay, when in solution, to the action of one or more magnets, or by passing through the bath containing such solution a current of electricity.

239300—March 22, 1881. A. Ryder. *Apparatus for treating ores.*

The invention has reference to apparatus for reducing ores in which the ore, while in a heated state, is dumped suddenly into a liquid or chemical solution for the purpose of disintegrating the ore and separating the particles preparatory to amalgamation. And the inventor claims, in an apparatus for disintegrating ores preparatory to amalgamation, the insulated vessel or nonconductor of electricity, provided with a metallic or plated hopper, in combination with an electrical generator or battery and conducting wire or wires.

246201—August 23, 1881. E. Reynier. *Electro-chemical treatment of ores.*

The method of treating ores of zinc and lead for the production of electricity and recovery of the metals by acting upon said ores in a voltaic couple with an electrolytic liquid having caustic alkali as the base, and precipitating the metallic oxides from said liquid.

272391—February 13, 1883. A. Thiollier. *Process of and apparatus for extracting metals from their ores.*

In combination with an electro-generator, a receptacle for conductively prepared ore or other material containing metal to be recovered, having attachments for the negative and positive polar conductors of the electro-generator, arranged, as described, in electrical communication with the mass of conductive ore by means of the electrolytic solution, whereby reduction is effected when the current is passed.

286208—October 9, 1883. L. Létrange. *Process of and apparatus for reducing zinc ores.*

The process of reducing zinc ores and producing pure metallic zinc and sulphuric acid simultaneously therefrom, which consists in simultaneously roasting sulphuret ores and carbonate ores in the same or communicating chambers, and thereby converting both ores into soluble sulphates, then leaching these roasted ores, and then depositing the metallic zinc from a solution of the sulphates by electric currents on metallic plates, and drawing sulphuric acid at the same time from the solution as fast as set free by the said electric currents; and the apparatus for use in the process of reducing zinc ores, which consists, essentially, in a reservoir for the sulphate solution; a precipitating vessel provided with suitable anodes and cathodes; a pipe provided with a regulating cock, leading from the reservoir to near the bottom of the precipitating vessel, and an outlet pipe for the freed acid, arranged in the said vessel at the desired level of the liquid therein, whereby the strength and quantity of the sulphate solution in the precipitating vessel are maintained constant.

291670—January 8, 1884. M. Body. *Process of and apparatus for obtaining gold and silver from their ores by combined electrolytic and amalgamating processes.*

The method of first subjecting gold and silver ores to the action of ferric salts, in combination with the electrolytic process, and the subsequent amalgamation of the metals with mercury under the continued action of the electric current; and the apparatus for effecting this process.

300950—June 24, 1884. H. R. Cassel. *Process of and apparatus for the separation of metals from ores and alloys.*

The process of separating metals from ores or alloys, especially those of an auriferous character, which consists in charging the ore or alloy in a powdered condition into an anode compartment, which is separated from the cathode compartment by porous material, said anode compartment containing a solution yielding nascent chlorine under the action of an electric current, and agitating said powdered material within said solution during the passage of the electric current; and the combination in an apparatus for treating ores and metals by electrolysis, of a cathode compartment, a negative pole therein, a rotary drum constituting the anode compartment, provided with porous material separating it from the cathode compartment, and with a series of carbon rods or plates arranged within the same, and suitable electric connections.

300951—June 24, 1884. H. R. Cassel. *Process of chloridizing ores by electrolysis.*

In the process of extracting gold from rebellious or refractory gold ores, the steps which consist in subjecting the ore to the action of a solution yielding nascent chlorine under electrolytic decomposition, and adding lime or its equivalent, whereby acids formed by secondary action during said decomposition are neutralized.

317245—May 5, 1885. E. P. Thompson. *Apparatus for the separation of gold from its ores by electro-chlorination and deposition.*

The combination, with an electrolytic cell for separating chlorine from its compounds and its anode, of a battery, a cathode consisting of a pipe through which steam is admitted to the cell for the purpose of increasing the rapidity of the separating, and conductors respectively connecting the same anode and cathode with the poles of said battery.

317246—May 5, 1885. E. P. Thompson. *Apparatus for the electro-deposition of gold from its chlorides.*

The combination, in an electrolytic cell, of an anode formed of a series of carbon rods set in a metal ring, and a cathode formed by two thin corrugated copper plates connected electrically, which are set, respectively, within and without the circle of carbons.

332705—December 22, 1885. H. H. Eames. *Apparatus for chloridizing gold, silver, and other ores.*

This invention consists of an iron vessel cylindrical in shape, lined with wood, having a cast iron cover, adjusted so as to be steam and vapor tight. It is also arranged with a set of stirrers, to which motion is communicated by crown and pinion wheels. It is also fitted with pipes, by means of which steam can be forced through the contents and held there under pressure. It is also furnished with two electrodes, by which electricity can be passed through the ore and chemicals operated upon, while the pressure is applied. The electric current is best obtained from a dynamo machine of ordinary construction used in the deposition of metals.

333815—January 5, 1886. M. Body. *Process of obtaining gold, silver, copper, nickel, and cobalt from their ores by electrolytic action.*

The process of separating gold, silver, copper, and other metals from chlorinated or chlorine containing ores by electrolytic action, consisting in first roasting the ores or subjecting them to an equivalent oxidizing treatment, as specified, and then subjecting the ore to the action of ferric-salt solutions, and at the same time passing an electric current through said solution, whereby the metal becomes dissolved and precipitated, and chlorine gas is generated at the positive pole, which reconverts the resulting ferrous salts into ferric salts.

351576—October 26, 1886. H. R. Cassel. *Process of extracting gold, etc., from ores.*

The process of separating metals from ores or alloys, especially those of an auriferous character, which consists in charging the ore or alloy in a powdered condition into an anode compartment, which is separated from the cathode compartment by a porous partition composed of asbestos, which permits the passage of the current with the metals in solution, and retains the ores within the anode compartment, said anode compartment containing a chloride solution, agitating and subjecting the charge to nascent chlorine produced from said solution during the passage of the electric current, passing the solution of metals through the asbestos partition, and depositing the metals in solution at the cathode.

357659—February 15, 1887. D. G. Fitzgerald. *Obtaining chlorine by electrolysis.*

The electro-chemical generation of chlorine by means of an anode of peroxide of lead in the form of dense, highly conductive layers, plates, or masses of any required form preferably obtained by the means hereinbefore described, the said anode being employed in conjunction with any suitable cathode and with an electrolyte capable of evolving chlorine.

360852—April 12, 1887. H. R. Cassel. *Apparatus for separating metals from ores or alloys.*

In an apparatus for separating metals from ores or alloys by electrolysis the combination of a journaled drum provided with carbon anodes, a hollow metallic shaft insulated on its exterior and extending through said drum, said shaft being perforated within the drum and separated from the interior thereof by a filter, and a screw conveyor within said hollow shaft.

360853—April 12, 1887. H. R. Cassel. *Apparatus for separating metals from ores or alloys.*

In an apparatus for separating metals from ores or alloys by electrolysis the combination of a rotary drum constituting the anode compartment and having a suitable electric connection, a rotary cathode compartment having a suitable electric connection and provided with an automatic valve, a porous diaphragm separating said anode and cathode compartments, a fixed bracket, and an arch shaped arm attached to said bracket in the path of said valve for opening of the latter.

362022—April 26, 1887. H. Liepmann. *Apparatus for separating metals from ores or alloys by electrolysis.*

In an apparatus for separating metals from ores or alloys by electrolysis the combination of an anode compartment, a cathode compartment, a filtering diaphragm separating said compartments, a dense porous diaphragm for separating said compartments during one step of the operation, and mechanism whereby the dense porous diaphragm may be placed in apposition with or removed from the opening between the anode and cathode compartments.

379764—March 20, 1888. C. F. Crosselmire. *Wet process of extracting pure zinc from its ores.*

The process which consists in immersing roasted zinc ore in dilute acid, passing an air blast through the solution until the impurities are oxidized, and finally drawing off the zinc solution and depositing or precipitating the zinc.

387036—July 31, 1888. C. P. Bellows. *Process of cleansing gold and silver where mechanically coated in ores with refractory substances.*

The process of cleansing refractory ores prior to the recovery of the precious metals therefrom, which consists in immersing said ores in a solution of a sodium chloride and caustic soda, heating said solution, and at the same time subjecting the ores to the action of the electric current, whereby the ore is rendered free milling.

391360—October 16, 1888. H. H. Eames. *Apparatus for chloridizing ores.*

In a device for chloridizing metallic ores, the combination of a hermetically sealed tank, metallic plates placed inside the said tank and mounted upon insulated supports, whereby they will be insulated from each other and from the tank, the said plates forming the two elements of a galvanic battery, a stirrer placed in the said tank and between the said plates a solution containing the ore to be treated, by which a galvanic current will be excited between the said charging steam in the said tank, whereby the said solution will be heated and a pressure maintained in said tank.

399209—March 5, 1889. J. H. Rae. *Electric amalgamator.*

In an apparatus for working ores, a pan or tub with an internal copper ring and rotating arms or stirrers, in combination with a horizontal wooden ring suspended above the tub, a copper plate forming the upper surface of said ring and perforated to admit carbons which pass loosely through the plates, said carbons having heads or transverse pins at the upper ends, and the movable elastic plates or springs pressing upon the heads of the carbons to hold them in contact with the copper plate.

407386—July 23, 1889. J. C. Wiswell. *Bath or solution for separating metals from their ores.*

The process of producing a bath or solution for the separation of metals from their ores, consisting in subjecting a solution of salt water, muriate of ammonia, and muriatic acid to a current of electricity, then placing this solution in a tank containing liquid mercury, and subjecting the whole to a current of electricity, said mercury serving as the anode.

410428—September 3, 1889. J. C. Wiswell. *Solution for use in separating metals from their ores.*

A solution or bath for use in separating metals from their ores, consisting of chlorine in solution, sodium chloride, ammonium chloride, hydrochloric acid, and bichloride of mercury.

415576—November 19, 1889. W. von Siemens. *Process of electrodeposition of metals.*

The process which consists in lixiviating ore in separate vessels with a solution containing ferric sulphate, passing the resulting ferrous sulphate successively through a series of compartments containing cathode plates, and in which cells the solution is subjected to the action of an electrical current by which the metal in solution is deposited, then passing the remaining liquid successively through a second series of compartments containing anode plates of insoluble material and separated from the first-mentioned compartments by nonmetallic diaphragms, whereby the ferrous sulphate is oxidized and reconverted into ferric sulphate, which solution is again used to lixiviate ores.

418134—December 24, 1889. H. F. Julian. *Process of extracting gold and silver from their ores.*

The improvement in the process of extracting gold and silver from ores, which consists in agitating the pulverized ore in closed vats with chlorine, bromine, or iodine and water under pressure of a fluid forced into the vat, and after the gold and silver have combined with the halogen, adding mercury and again agitating under pressure of a fluid forced into the vat, next passing the ore, mercury, and solution over amalgamated copper surfaces forming the cathode of an electric circuit, and subsequently submitting the mixture to electrolytic action between cathodes of mercury below and suitable anodes above.

452125—May 12, 1891. W. von Siemens. *Apparatus for extracting metals from their ores.*

The combination of a trough for the flow of liquid, composed of numerous sections connected at alternate ends, with an inlet at one end and an outlet at the other, with two longitudinal shafts in each section of the said trough, said shaft carrying beaters and being entirely immersed in the liquid contained in the trough, and a heating pipe located below and between the said shafts.

459923—September 8, 1891. C. Schreiber and H. Knutsen. *Process of extracting antimony from ores.*

In the extraction of antimony from ore, the process which consists in subjecting the crushed ore to the action of a solution of sulphide of sodium and then precipitating the antimony in metallic form by electrolysis, adding hydroxide of sodium to the solution.

460354—September 29, 1891. W. von Siemens. *Apparatus for electrolytically separating metals from ores.*

In an electrolytical cell, the combination of a revolving cathode, a trough shaped anode situated below the said cathode, in the trough of which the cathode revolves, a screen permitting the passage of the electrolyte and of electricity and capable of preventing the passage of vibrations of the electrolyte situated between the said cathode and anode, and means for supplying the electrolyte above the screen and for withdrawing the oxidized liquid from the bottom of the trough of the anode.

473105—April 19, 1892. G. J. Atkins. *Electrolytic apparatus for separating gold and other metals from their ores.*

Electrolytic apparatus for separating gold and other metals from their ores, which consists of an upright anode compartment through which the ore is passed continuously, having within it an anode constructed to receive and retard the descent of the ore, while the ore itself forms a more or less soluble portion of such anode pole, and an upright cathode compartment and pole, the said anode and cathode compartments communicating through an opening closed by a porous diaphragm and having outlets at their lower ends for the removal of the ore which has been acted upon in the anode compartment and of the metals and other substances that have been deposited or precipitated in the cathode compartment.

484869—October 25, 1892. G. J. Atkins. *Process of separating gold and other metals from their ores.*

The continuous process of separating gold and other metals from their ores, which consists in passing such ore through the anode compartment of an electrolytic apparatus in contact with the anode and retarding the descent of the ore in the said anode compartment while such ore is kept in contact with the anode pole of such compartment, so as to form a more or less soluble portion of such anode pole, and then subjecting the ore to the process of amalgamation.

495212—April 11, 1893. J. F. Wiswell. *Process of, and apparatus for, treating ores.*

An improved process of treating ores which consists in submerging mercury in a solution of common salt connecting the mercury with the positive pole of a generator and the salt solution with the other pole, so that the current will decompose the salt solution and cause the chlorine to be attracted to the mercury forming calomel; treating the calomel with aqua regia forming a soluble mercuric chloride, diluting the latter with water, treating undecomposed salt solution with an electric current to produce sodium hypochlorite and introducing the soluble mercuric chloride and sodium hypochlorite simultaneously upon the crushed ore.

495687—April 18, 1893. J. Pfleger. *Process of extracting zinc by electrolysis.*

The process of obtaining zinc by electrolysis out of a zinc containing anode, which consists in adding to the bath a basic zinc-salt solution adapted to act as electrolyte, to which basic zinc-salt solution a conducting neutral salt has been added.

495715—April 18, 1893. S. R. Whitall. *Process of lixiviating ores.*

The process of separating gold and silver from their ores, which consists, first, in roasting the ore to oxidize the base metals; and, secondly, in subjecting the roasted ore to the action of a solution of potassium cyanide and sodium hyposulphite, and subsequently precipitating the dissolved metals; and the process of separating gold and silver from siliceous ores, which consists in subjecting the ore admixed with caustic soda and potash to the action of a solution of potassium cyanide and sodium hyposulphite.

497014—May 9, 1893. F. W. Cleghorn. *Process of separating precious metals from ores.*

The process of separating gold and silver from ores, consisting in filtering through the ores a solution of sulphuric acid and salt, and precipitating the gold and silver in the filtrate solution by placing metallic iron in the filtrate and passing an electric current through the filtrate.

501997—July 25, 1893. S. H. Emmens. *Apparatus for the electrolytic extraction of metals.*

In apparatus for the electrolytic extraction of metals, a vat having an anode lining on its floor and sides, in combination with a suitable cathode or cathodes suspended within the vat and a nonporous and nonconducting inner wall or curb located between the side linings and the cathode or cathodes and extending from the upper surface of the floor lining to above the surface of the electrolyte, and serving to support a lining of the substance to be acted upon in contact with the anode side linings and to prevent short-circuiting between said anode side linings and the cathodes.

507130—October 24, 1893. C. Hoepfner. *Electrolytic production of metals.*

The process of obtaining copper and silver free from other metals, which consists in forming a cuprous chloride solution of these metals by leaching a cupriferous and argentiferous material with a cupric chloride solution containing a solvent for cuprous chloride, separating from the cuprous chloride solution so obtained such metals as arsenic, antimony, cobalt, and the like, extracting the silver by precipitation, electrolyzing the cuprous chloride solution, preventing the solution at the anode from commingling with the solution at the cathode, mixing together the two solutions after having been acted upon by the electric current and preventing an accumulation of iron therein by oxidizing and removing the latter.

512361—January 9, 1894. P. C. Choate. *Art of producing metallic zinc.*

The method of producing from an impure solution of zinc salts a zinc electrolyte free from depositable impurities, which consists in subjecting the solution to the action of an electric current to precipitate and deposit the depositable impurities, and at the same time preventing the re-solution of such impurities in the solution by neutralizing the acid set free in the bath with a neutralizing agent which is free from any depositable impurities soluble in the solvent element of the bath.

512362—January 9, 1894. P. C. Choate. *Process of preparing solutions carrying salts of zinc.*

The process of forming a solution carrying salts of zinc, which consists in forming a sulphate solution of the soluble elements of the ore and recovering the same therefrom by evaporation and crystallization, heating the crystallized product to drive off the salts of metals more volatile than zinc and convert those less volatile than zinc into compounds insoluble in water and finally treating the mass with water to dissolve the zinc element.

518732—April 24, 1894. P. C. Choate. *Art of producing metallic zinc.*

The process of continuously producing metallic zinc by electrolysis, which consists in depositing the zinc from an acidulated solution of a zinc salt, drawing off from the bath the free acid liberated therein, dissolving in such acid oxidized zinc, in the state of fume, freed from its more volatile soluble impurities, and returning the solution thus formed to the bath from time to time, as required, to maintain the electrolyte.

526099—September 18, 1894. P. Danckwardt. *Apparatus for and process of extracting gold or silver from ores.*

The process of extracting gold and silver from ores, which consists in subjecting the same simultaneously to the action of cyanide of potassium, an alkali sulphide, and to electrolysis; and the combination of a main apparatus consisting of a revolving outer drum having blades, an insulated inner drum and electric connections, with an auxiliary apparatus consisting of a series of communicating tanks, rotating insulated drums and electric connections.

528023—October 23, 1894. L. Pelatan and F. Clerici. *Extracting gold from its ore.*

The combination with a crushing mechanism and an amalgamator, of a series of vessels containing a solution of cyanide of potassium and a salt of sodium, each vessel having an amalgamated copper bottom connected to one pole of a generator of electricity and a central shaft having a zinc pipe and agitator connected to the other pole, a filter, a series of communicating closed vessels of lead, each containing a body of aluminum chips resting on a perforated diaphragm above the inlet and rising nearly to the outlet, and means for creating a vacuum beneath the filter to drive the fluid through and into the series of lead vessels under pressure.

531169—December 18, 1894. V. Engelhardt. *Process of extracting metals from sulphide ores, etc.*

The process of treating the sulphur compounds of metals, which compounds have combined therewith other ore compounds not soluble in a solution of an alkaline sulph-hydrate, which consists in extracting the sulphur compounds by treatment with an alkaline sulph-hydrate, thereby also generating sulphureted hydrogen, subjecting the solution thus formed to the action of an electric current in the cathode compartment of an electrolytic cell, in the anode compartment of which is an alkaline chloride, thereby obtaining the metals, reforming the sulph-hydrate, and liberating free chlorine, treating the ore residues, resulting from the sulph-hydrate bath with such chlorine, and subjecting the solution thus obtained to the action of the sulphureted hydrogen first generated in the sulph-hydrate bath.

537423—April 9, 1895. F. H. Long and D. C. Skaden. *Apparatus for recovering precious metals from their ores.*

An apparatus for recovering precious metals comprising a revoluble drum, a perforated metal tube opening from said drum and provided with a fabric jacket, a series of plates secured to the inner surface of the drum and having inwardly extending blades or flanges electric connections to the plates and tube for rendering the same of opposite polarity, a rotatable conveyor located and working in said tube and a fixed vent pipe passing axially through the drum head and opening into the interior of the drum near the top thereof.

538522—April 30, 1895. E. D. Kendall. *Process of and reagent for recovering silver and gold from solutions.*

The process of the recovery of gold and silver from solutions, which consists of the following steps: (first) the subjecting of the ore containing the precious metals to the action of a solvent, thus obtaining an aqueous solution of the solvent and the minerals contained in the ore; (second) subjecting the said solution to the electro-chemical action of a mercurial amalgam; (third) subjecting the valuable precipitate secured by the preceding process to the action of dilute acid in the presence of carbon; (fourth) the recovery of the valuable metal from the result of the preceding process.

543546—July 30, 1895. E. J. Fraser. *Process of and apparatus for treatment of precious metals.*

The process of separating gold or other precious metal held in an electrolytic solution, which consists in passing the solution through a vessel containing alternating porous layers of zinc and carbon, to set up a local voltaic action which tends to decompose the solution, precipitating the gold in the carbon by filtration.

543673—July 30, 1895. M. Crawford. *Process of extracting precious metals from their ores.*

The improved process of removing precious metals from their ores which consists, first, in lixiviating the ore with a cyanide solution which has been subjected to the action of an anode separated from its corresponding cathode by a porous partition which substantially prevents the circulation of the electrolyte; second, in withdrawing said solution and removing the precious metals therefrom; third, in again subjecting the solution to the action of an anode separated from its corresponding cathode as before and using it over again in continuous rotation.

543674—July 30, 1895. M. Crawford. *Process of extracting precious metals from their ores.*

The improved process of extracting precious metals from their ores, which consists in forming a solution of a cyanide and a cyanate of the corresponding base, the total amount of cyanate being not less than 25 per cent of the total amount of cyanide present; lixiviating the ore therewith and extracting the dissolved precious metals from said solution.

543675—July 30, 1895. M. Crawford. *Apparatus for extracting precious metals from their ores.*

An apparatus for extracting precious metals from their ores, which consists in the combination of a tank wherein the solvent liquid is stored; a revoluble lixiviating receptacle; a pipe running from said storage tank to the lixiviating receptacle; an amalgamating table; means for causing the lixiviating receptacle to discharge its contents continuously upon the amalgamating table; a separating tank; means for conducting ore which has passed over the amalgamating table into the separating tank; means for separating the solid contents of this separating tank from its liquid contents; a third tank; connections whereby the solvent liquid thus separated is passed to said third tank; means for reclaiming the precious metals from the solution in said third tank; and connections whereby the solvent liquid is run from the third tank to the storage tank; and a separator for removing the tailings of the ores of precious metals from their accompanying solvent solution, which consists in the combination of a tank into which the ores and solution are discharged; a conveyer running from the bottom of said tank to a point exterior thereto by which the solids are separated from the liquids; a car filter with a permeable bottom situated below the discharge end of the conveyor; and a second tank below said car filter.

544610—August 13, 1895. E. W. Clark. *Process of and apparatus for extracting ores by electrolysis.*

In an electric chlorinator for gold ores, the combination of the hollow cylinder constructed in longitudinal sections united by bands, and having the series of separate boxes or chambers communicating with its interior; the electrical connections consisting of the anode in the cylinder chamber, and the cathodes in the boxes or amalgamating chambers, the agitator shaft provided with the spirally arranged series of stirrer arms and adapted to revolve in the cylinder chamber, and the stuffing boxes at the ends of the cylinder.

546873—September 24, 1895. E. A. Ashcroft. *Process of treating zinc-bearing ores.*

In the treatment of zinc bearing ores and zinc bearing products, the method of simultaneously depositing zinc from a catholyte free from iron, and raising a ferrous salt solution to the ferric state, which consists in passing the zinc bearing solution free from iron, around the metallic cathodes of an electrolytic apparatus, and simultaneously passing the ferrous salt solution around the insoluble anodes of the said electrolytic apparatus.

549907—November 19, 1895. A. L. ELTONHEAD. *Apparatus for extracting gold.*

In an apparatus for extracting gold and other metals, the combination of a mercury receiving box, a horizontally movable vessel therein, having its lower end open and unobstructed whereby mercury placed within the box may, in seeking its level, enter said vessel, a horizontally placed anode strip suspended within the latter, means for adjusting the strip vertically, a cathode connection and conductor wires adapted to connect the anode and cathode with a suitable dynamo or battery.

551648—December 17, 1895. L. PELATAN and F. CLERICI. *Electrolytic process of obtaining precious metals.*

In an apparatus for the extraction of precious metals by direct electrolytic action, the combination with an electrolytic vat having cathodes arranged at its bottom, of anode cylinders arranged above the said cathodes, anode plates alternating with said cylinders, a generator of electricity having its poles connected to said anode cylinders and plates and to the cathodes, means for rotating the anode cylinders which are provided with agitators, a force pump having injection pipes to discharge beneath the anode plates and cylinders, said pipes being provided at or near their mouths with interior, concentric rods having spiral ribs, or feathers, and suction pipes having their open ends arranged above the anode plates.

552960—January 14, 1896. C. HOEPFNER. *Process of producing cuprous oxides.*

The process which consists in leaching cupriferous materials with a cupric chloride solution containing calcium chloride, whereby a solution containing cuprous chloride is obtained, converting the cuprous chloride in a portion of the solution into cupric chloride by means of a suitable acid as sulphurous acid in the presence of oxygen, freeing the other portion of the solution from metals other than copper, and converting the cuprous chloride therein into cuprous oxide by means of a suitable reagent, as caustic lime.

553816—January 28, 1896. L. PELATAN and F. CLERICI. *Process of and apparatus for extracting gold from its ores.*

A single continuous process for the extraction of precious metals from their ores, and the amalgamation of the same, which consists in treating said ores with a comparatively weak solution of a soluble cyanide, such as cyanide of potassium, adding thereto a peroxide such as hydrogen binoxide, increasing the electric conductivity of said solution by adding chloride of sodium, increasing the solvent power of said solution by passing a relatively weak current of electricity through the same, retaining the sodium chloride in the solution practically without decomposition and continuously revolving the anode in the solution over a fixed cathode of mercury.

556092—March 10, 1896. O. FRÖLICH. *Process of extracting noble metals from ores.*

The process of extracting precious metals from a lye containing also inferior metals, said lye containing substantially five grains of each of the said metals to the pint, which consists in subjecting the said lye to the action of an electric current of substantially twelve amperes for each two square yards of cathode surface, whereby the gold is separated by electrolysis.

563143—June 30, 1896. J. DOUGLAS. *Process of extracting copper from ores.*

The method of extracting copper from solid cuprous chloride, which consists in moistening said solid cuprous chloride with water, inserting both electrodes of an electric circuit in the said solid cuprous chloride, and then passing an electric current therethrough.

563144—June 30, 1896. J. DOUGLAS. *Process of extracting copper from ores.*

The process of extracting copper from the solid cuprous chloride, which consists in suspending the said solid cuprous chloride in an acidulated electrolyte, inserting the cathode of an electric circuit into the solid cuprous chloride, and the anode into the electrolyte, and passing an electric current therethrough.

566894—September 1, 1896. P. DANCKWARDT. *Apparatus for extracting gold and silver from ore.*

The combination of a revolving barrel having an amalgamated copper lining with nonconducting bottoms, a series of inclined perforated metal strips secured to such bottoms, insulating rings that sustain the bodies of such strips, and with electric connections that communicate with the barrel and the strips.

566986—September 1, 1896. R. KECK. *Cyanide process of extracting precious metals from their ores.*

The process of extracting precious metals from their ores, which consists in dissolving said metals in a cyanide solution and extracting them therefrom by electrolytic precipitation effected by alternating plates of lead and aluminum, the former being anodes and the latter cathodes.

567503—September 8, 1896. L. PELATAN and F. CLERICI. *Process of extracting gold and silver from their ores.*

The process, which consists in submitting the ores of gold and silver to the action of a comparatively weak cyanide solution containing chloride of sodium, intensifying the solvent power of the solution by the passage of a continuous electric current having an electro-motive force below that required for the decomposition of sodium chloride, and continuously revolving the anode from which the current is supplied to the solution over a mercury cathode.

568090—September 22, 1896. L. PELATAN and F. CLERICI. *Electrolytic apparatus for extracting gold and silver from their ores.*

The combination with a vat having a flat bottom, of a cathode of mercury spread thereon, an anode having the form of an endless belt, rolls arranged near the ends of the vat to support and give continuous movement to said anode in parallelism with the surface of the cathode, and means for imparting continuous movement to said anode, in one direction, it being provided with stirring devices moving with it.

568724—October 6, 1896. E. ANDREOLI. *Apparatus for electro-deposition of gold or silver.*

In an apparatus for the electro-deposition of gold and silver from a solution, a tank provided with one or more anodes and a series of amalgamated cathodes, each cathode consisting of perforated, skeleton, or network plates and a layer of mercury in the bottom of the tank into which each of the cathodes dips, said layer of mercury being connected with the negative pole of electricity, thereby constituting a common vehicle for the current from all the cathodes while at the same time maintaining the said cathodes constantly amalgamated.

568741—October 6, 1896. H. R. CASSEL. *Process of extracting gold from substances containing it.*

The process of extracting gold from ores, which consists in decomposing a bromide of an alkaline base by electrolysis, dissolving the gold by the anode solution, adding the cathode solution, running the product through a mixture of iron and carbon to precipitate the gold, and redecomposing the liberated bromine solution by electrolysis.

568843—October 6, 1896. V. ENGELHARDT and A. NETTEL. *Process of treating metallic sulphides.*

The process of treating a metallic sulphur compound, which consists in first converting the said compound into a soluble double sulphide by treating it with any suitable reagent, such as the sulph-hydrate of calcium in aqueous solution; then decomposing the resulting solution by electrolysis to produce the metal and sulphureted-hydrogen gas, then treating the spent solution with carbonic acid gas to precipitate a carbonate of the base and liberate sulphureted-hydrogen gas, then recovering the oxide of the reagent and the carbonic-acid gas from the precipitate by calcination, then combining the sulphureted-hydrogen gas given off during the process with the said oxide to form more reagent, and using the recovered carbonic-acid gas to treat more spent solution.

571368—November 17, 1896. T. P. BARBOUR. *Process of treating ores.*

The process of treating ores, which consists in first treating the raw material with copper oxide and sulphuric acid, then chlorinating the pulp thus treated, introducing the chlorinated mass into a suitable agitator having zinc therein, and establishing an electric current through the mass in the presence of zinc; and a chlorinating tank for treating ores consisting of a revoluble cask having a single manhole and a circular series of bungholes, copper pole disks secured within the cask at opposite ends thereof and arranged in an electric circuit, insulator bracing posts arranged between said disks and the outer heads of the tank, flanged guide rings encircling said cask at an intermediate point, spurrings encircling the cask near its opposite ends, and a horizontal drive shaft carrying guide rolls engaging said flanged guide rings and drive pinions engaging said spur rings.

573255—December 15, 1896. M. NETTO. *Process of precipitating precious metals from their alkali cyanide solutions.*

The process of precipitating silver and gold from their alkali cyanide solutions, which consists in acidulating the alkali cyanide solution containing said metals with hydrochloric acid so as to precipitate silver chloride, separating said silver chloride by filtration, subjecting the acid filtrate to the action of the electric current so as to deposit the gold on the cathode, and regenerating the cyanide solution by the addition of caustic alkali.

578171—March 2, 1897. C. P. TURNER. *Electrolytical apparatus.*

An electrolytic apparatus, provided with an anode consisting of a nonconducting receptacle coated with an anticorrosive substance and provided with an outer coating of a conducting material and means for connecting said outer coating with the positive pole of a source of electrical supply.

579872—March 30, 1897. J. H. HAYCRAFT. *Process of treating auriferous and argentiferous ores.*

The process of treating ores consisting in introducing the ore into a pan, adding thereto mercury and soluble salts capable of yielding chlorine by electrolysis, raising the ore contents of the pan to about the boiling point of water and passing a current of electricity through the heated mass while stirring the same to secure a simultaneous electrolytic chlorination and electro-amalgamation, and maintaining the anode out of vertical alignment with the mercury cathode.

581160—April 20, 1897. H. HIRSCHING. *Process of treating ores containing silver and gold.*

The process of treating ores, which consists in subjecting them in the presence of moisture to the action of ammonia and a nitrate, and then precipitating the metal or metals from the resulting solution.

582077—May 4, 1897. E. MOTZ. *Apparatus for extracting precious metals.*

In an apparatus for extracting precious metals, the combination of a rotative drum provided with a manhole and having a valved connection for the admission of compressed air, a core of insulating material mounted to turn in the said drum, metal plates forming the positive and negative electrodes of an electric circuit and arranged respectively on the drum and core, and an electrical connection for said plates on the core, the said connection being arranged to lock the drum and core together.

584242—June 8, 1897. P. G. SALOM. *Process of making commercial lead from lead ore.*

The process of converting lead ore into commercial lead, without the application of heat, by subjecting the ore to the action of nascent hydrogen, electrolytically developed, producing thereby a spongy mass, and afterward, while the mass is in a nonoxidized condition, applying a consolidating pressure.

585355—June 29, 1897. C. A. BURGHARDT and G. RIGG. *Process of obtaining metallic zinc and copper from ores.*

The improved process of recovering metallic zinc and metallic copper from cuprous zinc ore, which consists in treating the roasted and ground ores with an ammoniacal solution, then in freeing the resultant liquid from iron dissolved by said solution, then in depositing the metallic copper on suitable metallic plates acting as a couple, and in finally effecting the electrolytic deposition of the metallic zinc.

585464—June 29, 1897. J. F. WEBB. *Method of an apparatus for separating precious metals from their solvent solutions.*

The improved method of separating precious metals from a solvent solution containing the same, consisting in passing the solution alternately through a body of carbon and zinc, and subjecting the same in its passage to an air current; and a metallurgical filter for this purpose containing the same, consisting of a series of alternate compartments, or receptacles, containing, respectively, carbon and zinc, through which the solvent solution is passed with an upward and downward flow, and electric circuit completing connection between the zinc and carbon.

588026—August 10, 1897. B. MOHR. *Process of treating sulphide ore.*

The process for treating sulphide ore by acting on the pulverized ore with acid sodium or potassium sulphate, so as to obtain a solution of sulphate of zinc, depositing the zinc by electrolysis and thus recovering the acid alkali sulphate, and treating the insoluble residue obtained by the lixiviation for recovery of the other metals.

588740—August 24, 1897. B. BECKER. *Apparatus for treating gold and silver ores.*

In apparatus for the treatment of gold and silver ores the combination of a vat provided with amalgamating plates and adapted to contain cyanide of potassium, in solution, and the ore to be treated, a vat containing the electrodes of an electrolytic apparatus and means for causing the circulation of the cyanide of potassium solution through the amalgamating vat, and for distributing it in the electrolytic vat.

590801—September 28, 1897. W. L. BROWN. *Process of treating rebellious ores.*

The process of treating ores finely divided and mixed with water, which consists in adding a suitable compound to said ores and water, which compound contains an element which has a chemical affinity for the base constituents of the ore, then passing an electric current through said material to unite the said element chemically with the base constituents and to liberate the precious metals, then circulating the material over an amalgamated surface which is not in the electrical circuit, and finally returning the material again through the field of electrolytic action.

592055—October 19, 1897. E. C. KETCHUM. *Process of treating ores.*

The process of treating mixed sulphide ores containing lead and zinc, which consists in first roasting the ores, then subjecting the roasted ores to the action of a solution of caustic alkali in the presence of heat to remove from the ores the lead and the zinc, then subjecting the caustic solution containing the lead and zinc to electrolytic action in one or more cells to remove the lead, the anodes of which cells are immersed in a volume of pure caustic solution, which is separated by a porous medium from the electrolyte containing the lead and zinc, and then subjecting the caustic solution or electrolyte containing the zinc only to electrolytic action in one or more cells to remove the zinc.

592973—November 2, 1897. E. MOTZ. *Electrolytic apparatus.*

In an electrolytic apparatus the combination with a frame or sluice of a series of convex cathode plates located in the bottom of said frame or sluice, a series of anode plates having curved under faces and disposed above said cathode plates, blocks secured to the anode plates and supported in the frame or sluice, each block having a recess in its upper edge, a series of conductors connected with said anode plates and terminating in said recesses in the blocks, a conducting rod disposed in said recesses on the first-mentioned conductors and having a notch therein, a crossbar passing through said notch, a conductor with which said crossbar is electrically connected, locking devices for securing the crossbar to the frame or sluice, and a conductor connected with the cathode plates.

594611—November 30, 1897. S. H. Emmens. *Process of and apparatus for removing zinc from zinciferous ores.*

The process of treating zinciferous ores, which consists in pulverizing and roasting the ore, leaching it in a series of vessels through which the solution flows continuously, and subjecting the contents of each vessel intermittently to electrolytic action, whereby the solution is rendered alternately acid and neutral or more acid and less acid in contact with each body of ore; and an apparatus for treating zinciferous ores, comprising a series of leaching vats, each provided with an inlet pipe extending to the bottom and with an exit pipe or trough leading from the top of the vat, and each provided at bottom with an insoluble anode, a series of movable cathodes suspended above said vats, means for raising and lowering the cathodes of adjoining vats alternately, and an electric circuit to the respective poles with which said anodes and cathodes are connected.

597820—January 25, 1898. N. S. Keith. *Art of obtaining gold and silver from auriferous and argentiferous materials.*

The process of obtaining a precious metal from its ores, which consists first in dissolving the gold or silver in a cyanide solution containing cyanide of mercury and free cyanide of an alkaline metal, such as cyanide of potassium, and then passing a current of electricity through said solution to a metallic cathode, whereby an easily removable layer of the precious metal and mercury is simultaneously deposited upon said cathode.

598193—February 1, 1898. E. Andreoli. *Apparatus for electro-deposition of gold and silver.*

In apparatus for the electro-deposition of gold, silver, or other metals, anodes of peroxidized lead acting in the presence of and in combination with a cyanide or cyanide-compound solution.

600351—March 8, 1898. E. A. Ashcroft. *Treatment of metalliferous ores and products.*

The improved process of preparing a solution suitable for leaching zinc bearing ores of zinc bearing products, consisting in electrolyzing a zinc bearing solution successively in contact with a suitable cathode and an anode resulting from the preliminary furnace treatment of products or ores containing copper and iron, and then depositing the copper from the resulting ferrous solution, and simultaneously raising the iron content of such solution to the ferric state by electrolyzing the said resulting ferrous solution successively in contact with suitable cathodes and insoluble anodes.

601068—March 22, 1898. F. W. Whitridge. *Method of and apparatus for extracting gold from its ores.*

The method of extracting gold from a weak cyanide solution, which consists in circulating the solution over anodes of iron and cathodes of lead, said cathodes being formed of thin plates arranged at short distances apart and having from 9 to 10 square meters of surface for each ton of solution in contact with them; and subjecting the said solution while in motion to an electric current of from 3.5 to 4 volts, and of from 0.5 to 1.5 amperes per square meter of cathode surface; and in apparatus for obtaining gold from a weak cyanide solution by electrolysis, the combination with a cell provided with anodes of iron and cathodes of lead formed of thin plates, said cathode plates having from 9 to 10 square meters of surface to each ton of solution in the cell; of means for circulating the solution in the cell, and means for subjecting the solution to a weak current of electricity.

603904—May 10, 1898. J. R. Hebaus. *Apparatus for extracting precious metals.*

An apparatus for extracting precious metals from their ores, comprising a tank having an amalgamated copper lining forming a cathode and a multiplicity of agitators, each rotating on its own axis and at the same time traveling around the tank, the said agitators forming an anode and an electric circuit.

605885—June 21, 1898. E. and G. Andreoli. *Electrolytic production of amalgams, etc.*

An apparatus for the production of amalgam, consisting of a cell provided with positive and negative compartments separated by porous diaphragms, the negative compartments having a raised middle portion in the form of a table or block between the sides of which and the said partitions are narrow vertical spaces, the top of the block or table and the vertical spaces being covered and filled with a continuous body of mercury forming a cathode.

614572—November 22, 1898. J. C. McNulty. *Method of and apparatus for treating ores.*

The art of extracting precious metals from their ores, consisting in mixing pulverized ore with an electrolytic fluid, causing the mixture to flow from one level to another between adjacent electrode plates of opposite polarity, passing an electric current between said plates and vibrating the electrodes in a direction substantially at right angles to the plane of said electrodes for the purpose of preventing the polarization thereof; and in apparatus for the electrolytic treatment of ores the combination of a plurality of vats arranged in pairs communicating at the top, adjacent electrode plates of opposite polarity suspended within said vats and connected with a source of electricity, vibratory supports for said electrodes, means for vibrating the same at substantially right angles to their planes, a pressure conduit for pulp leading to the bottom of the first vat to provide an upward current therethrough, and an exit at the bottom of the succeeding vat providing a discharge for the downward current of pulp overflowing from the top of the vat preceding.

616891—January 3, 1899. G. D. Burton. *Electrolytic apparatus for treating metals and ores.*

In an electrolytic ore treating apparatus, the combination of a tank for containing an electrolyte, an anode disposed in said tank, a cathode disposed in said tank, a screen or deflector also disposed in said tank between the anode and cathode and adapted to distribute the ore or material being treated, said screen having a conductive surface connected to the negative pole of an electric source whereby it is adapted to collect a portion of the product reduced from the ore by the action of the current and the electrolyte.

617911—January 17, 1899. E. A. Smith and M. H. Lyng. *Method of extracting metallic ores.*

The wet process of extracting copper from its ores having precious metal therein, which consists in digesting the pulverized ore under action of heat and an oxidizing agent, in presence of sulphuric acid, exposing the dissolved sulphates to metallic copper for precipitation of the silver, treating the filtrate electrolytically to deposit the copper, evaporating the lean electrolyte to concentrate the free acid, and crystallize the metallic sulphates, and finally calcining such crystallized sulphates to properly regenerate them as oxidizing agents for reuse.

623822—April 25, 1899. L. Pelatan. *Apparatus for treating ores or the like.*

In apparatus, the combination with a circular vat, of a revolving anode, situated above and parallel to a mercury cathode, with an unobstructed space above the surface of the cathode, the said anode having arms which extend close to the peripheral wall of the vat and are suspended from a shaft, and are provided with pins or stirrers projecting upward and downward to within a short distance of the underlying cathode, and projections or baffles extending inwardly from the inner surface of the peripheral wall of the vat.

626972—June 13, 1899. T. Craney. *Electrolytic apparatus for deposition of metals from solution.*

In an electrolytic apparatus, the combination of an outer tank provided with suitable feed and discharge connections for the liquid into the bottom and top, respectively, and an electrolytic couple, composed of sheet or analogous electrodes each folded in a fabric, with oppositely projecting marginal portions and rolled together into a tight bundle and sealed in the tank, whereby the fabric inclosing the electrode forms a porous medium through which the electrode is compelled to flow.

627442—June 20, 1899. L. Pelatan. *Process of electrolytically treating ores.*

The improvement in processes of treating ores electrolytically, consisting in adding to a sludge, consisting of ore and water, a solvent and picric acid as an oxidizing agent and then passing an electric current therethrough.

631040—August 15, 1899. J. E. Greenawalt. *Process of extracting precious metals from their ores.*

A process for the treatment of gold and silver ores which consists, first, in properly roasting the pulverized ore; second, placing the ore in a filtering vat; third, washing the ore to remove soluble salts; fourth, in passing through the ore an electrolyzed solution consisting of a solution of chlorides—chiefly sodium and ferric chlorides—with a small percentage of bromides and small quantities of chlorine, bromine, and hypochlorous acid, with such other compounds as result from the electrolysis of a chloride and bromide solution; fifth, passing the solution after it leaves the ore through a precipitating tank; sixth, passing the solution after it leaves the precipitating tank through the positive or anode compartment of an electrolytic cell, keeping the solution separate and distinct from the solution in the negative or cathode compartment of the cell; and, seventh, returning the solution from the regenerating cell to the ore in the vat and passing it thence to the precipitating tank, again to the regenerating cell, and again to the ore as often as may be required to effect the necessary saving of the values.

633544—September 19, 1899. H. S. Badger. *Electrolytic apparatus for precipitating metals.*

A precipitating tank comprising the tank body, having a mercury coated surface in its bottom, a revoluble shaft suspended in the tank and provided with hollow arms having perforations on their lower sides to deliver air or vapor in proximity to the said surface, means for rotating the revoluble devices, means for introducing air or vapor to the hollow arms, and an electric circuit in which the shaft, agitating arms, and mercury coated surface are located.

639766—December 26, 1899. L. E. Porter. *Apparatus for extracting precious metals from ores.*

The combination of a rotatable barrel adapted to form the cathode; a porous lining of nonconducting material arranged inside the barrel; a lining of filtering material arranged inside the nonconducting lining; anode plates arranged inside the filter lining; a source of electrical energy, having one pole connected with the barrel and the other pole connected with the anode plates.

640718—January 2, 1900. C. P. Tatro and G. Delius. *Process of extracting precious metals.*

In the process of separating precious metals from ores, the steps comprising electrolytically depositing a portion of the precious metals in the bath upon a drum cathode revolving partially immersed in the bath, at the same time scraping the said deposit from the drum, also simultaneously depositing other portions of similar precious metals in the same bath upon a cathode of sodium amalgam.

641571—January 16, 1900. W. Witter. *Process of producing solution of cyanogen halide.*

The process for producing a solution of cyanogen halide by electrolyzing in a bath without a diaphragm and with inert electrodes a solution containing an alkali cyanide, an alkali halide, and the salt of a metal which forms an insoluble hydroxide.

649151—May 8, 1900. W. Wright. *Apparatus for extracting metals from refractory ores.*

An apparatus for extracting metals from refractory ores, comprising a tank for receiving a sludge of such ores; a stationary, horizontal, perforated partition in said tank, forming beneath it a chamber; a cathode on the bottom of the tank within said chamber; a filtering medium carried on the partition; a number of pins arranged in a series of concentric circles projecting upward from said partition; a main driving shaft; a series of radial arms supported by said shaft, and a plurality of anodes carried by said arms and working between the series of concentric pins.

650636—May 29, 1900. F. H. Long. *Apparatus for electrolytic reduction of ores.*

An electrolytic apparatus, the combination with a reducer vessel; its bottom cathode and a diaphragm above said cathode, of a set of dependent anodes, each consisting of a carbon head; a copper stem extended therefrom through the vessel; an incasing iron tube carried by the vessel head to sustain the anode pole; a vulcanite sheath for said tube, and suitable elastic gaskets to expansively close the joints.

653538—July 10, 1900. N. L. Turner. *Electrolytic apparatus.*

An electrolytical apparatus, comprising a tank, rotary agitators located therein eccentrically, a series of electrodes whose main portion is concentric with the tank, while the portions adjacent to the agitators are curved concentrically with the axes of said agitators, and electrodes of opposite polarity to those first named.

654437—July 24, 1900. W. A. Caldecott. *Method of extracting gold from cyanide solutions containing the precious metals.*

Means for extracting gold from cyanide solutions in depositing cells, consisting in a mechanical mixture of zinc shavings and lead shavings.

656305—August 21, 1900. W. Strzoda. *Process of electrolytically extracting zinc from ores.*

The process of electrolytically extracting zinc from its ores, which consists in placing the disintegrated or pulverized ore in its natural state in an electrolytic vat containing an aqueous alkali-metal solution capable of dissolving the ore, with production of a zincate and in direct contact with the cathode, and closing the circuit through the vat, thereby precipitating zinc and the alkali metal at the cathode, the alkali metal reacting with the water to regenerate the solvent solution.

657032—August 28, 1900. A. M. Rouse. *Apparatus for electrolyzing ores.*

In an apparatus of the class described having an anode and a cathode suitably arranged therein, the combination of a tank having an outer compartment, a tube located therein having an open upper end and provided at its lower end with openings forming communication from said compartment, a driving shaft projecting within said tube, an inner cup carried by said shaft, wings carried by said cup, an outer cup carried by said wings, a discharge duct, and a valve arranged to close said duct.

662286—November 20, 1900. E. Motz. *Electrolytic apparatus.*

In an electrolytic cell having open ends, the combination with a removable crossbar and means for supporting it in position, of a metallic plate covering the bottom and two sides of the bar, and forming the anode plate of the cell, of a metallic plate arranged horizontally below and parallel with the bottom of the crossbar, so as to form a passage between such plate and the bottom of the crossbar, such plate forming a cathode plate of the cell, and an auxiliary metallic cathode plate arranged vertically and parallel with the sides of the crossbar and in circuit with the horizontal cathode plate, such vertically arranged plate extending below the plane of the bottom of the crossbar, so as to more or less obstruct the said passage.

664537—December 25, 1900. J. Douglas. *Process of extracting copper.*

The process of reducing copper ore and matte, which consists in electrolyzing solid cuprous chloride, employing the gases evolved in the treatment of copper ore and matte, employing the electrolyte resulting from the electrolyzing of the solid cuprous chloride as a solvent for the cuprous chloride so produced, and recovering the copper from the solution by electrolysis.

668842—February 26, 1901. A. M. Rouse. *Apparatus for electrolytically extracting and depositing gold and silver from their ores.*

In an apparatus, the combination of a series of pulp receiving tubs, anodes and cathodes arranged in said tubs, an agitation tube having communication with said tubs at their upper and lower ends, an agitator arranged in said tube, perforated conduits located in the upper ends of said tubs, chutes located beneath said conduits onto which the ore pulp is discharged, and deflectors located beside said conduits adapted to direct the flow of pulp onto said chutes as it passes through said conduits.

669752—March 12, 1901. P. W. Knauf. *Electrolytic apparatus.*

An element for an electrolytic series, consisting of a metallic receptacle having its lower portion of less diameter than the upper portion and having a bottom surface which is inclined upward radially from the center to the outer periphery, in combination with an exterior peripheral seat arranged below the upper edge, and an orifice adjacent to said seat.

669926—March 12, 1901. C. Hoepfner. *Process of electrolytical extraction of metals.*

A process which consists in placing a soluble metallic anode in a solution capable of dissolving the same, placing a suitable cathode in a second similar solution containing a metal more electro-positive than that of the anode, interposing a third similar solution of less solution pressure between the two first mentioned, placing an auxiliary cathode therein, separating the solutions by suitable diaphragms, maintaining the solutions in motion and at a temperature above normal, passing a current, thereby dissolving the anode and precipitating the cathode metal at the cathode, and part of the diffused anode metal at the auxiliary cathode, precipitating the anode metal from the anode and intermediate solutions and returning the resulting solution when enriched in cathode metal to the cathode cell.

678526—July 16, 1901. C. P. Stewart. *Apparatus for the recovery of gold from cyanide solutions.*

An apparatus for recovering precious metals from flowing cyanide solutions, comprising in combination a relatively long substantially horizontal trough, means for supplying the solution at one end thereof, a partition near the receiving end of the trough for distributing the solution, a retaining partition at the discharge end of the trough adapted to retain the solution in the trough to the desired height, a body of quicksilver in the bottom of the trough between said partitions, a series of transverse anode supports extending substantially from partition to partition, a series of anodes adjustably mounted in said supports and extending down into the path of the flowing solution, and suitable electric connections.

682155—September 3, 1901. C. P. Tatro and G. Delius. *Electrolytic apparatus for extracting precious metals.*

In apparatus for extracting precious metals, a tub; a mercurial cathode in the bottom thereof, a principal anode, means for lowering it into and raising it out of the tub, and a minor anode permanently in the tub.

689018—December 17, 1901. W. Orr. *Method of recovering cyanides.*

The method of regenerating cyanide solutions which have become fouled by the presence of zinc and copper contained in the solutions, as double cyanide of zinc and copper with the alkaline metals which consists, first, in passing through the solution from a series of zinc anodes to a corresponding series of metallic cathodes a current of electricity; next, in introducing into such solution alkaline hydrate, being hydrate of the monovalent alkali metals and hydrate of the divalent alkali metals in the proportion of about two to one; next introducing into the solution a soluble alkali-metal sulphide, and finally removing the resulting zinc-sulphide precipitate.

689674—December 24, 1901. A. I. Irwin. *Machine for extracting metal from ore.*

In a machine for the automatic and continuous extraction and deposition of metal from ores at one and the same time, a treatment tank, an endless anode traveling in said tank, the upper and lower stretches of the anode being in position to be immersed in the solution in the tank, diagonally disposed blocks of insulating material attached to said anode, cathodes in the tank, one under each stretch of the anode, and connections with a source of electricity.

689959—December 31, 1901. E. L. Graham. *Process of disintegrating and comminuting minerals or ores.*

The process of treating ores, consisting of the following steps: First, immersing the ores in a solution of sulphuric and hydrofluoric acids incapable of dissolving the ore; second, passing an electric current of sufficient strength to disintegrate the ore through the solution; and third, extracting the metal from the ore.

699904—May 13, 1902. F. H. Long. *Electrolytic converter.*

In electrolytic converters, the combination with the closed reducer vessel having the anode and cathode terminals and the interposed diaphragm dividing the vessel into upper anode and lower cathode chambers, of a combined separator and vent pipe connected to the cathode chamber beneath the diaphragm extending upwardly above the level of said diaphragm and having a free outlet for the gases.

700941—May 27, 1902. N. S. Keith. *Process of treating copper or other ores for obtaining their contents of metals.*

The process of electrolyzing a solution of a metal; to deposit the metal therefrom, which consists in passing it as an electrolyte through a succession of two or more electrolytic cells, arranged so that the cells are connected in electrical series with a source of electricity; the anodes insoluble, the electrodes of each cell in electrical multiple, and having gradually increasing surfaces, whereby there is a gradual reduction of the current density as the metal of the electrolyte is deposited.

704639—July 15, 1902. C. Hoepfner. *Leaching and extraction of metals from their ores.*

The process of extracting metals, which consists in leaching a suitable material containing copper, lead, and silver, with a warm cupric-chloride solution containing a solvent of cuprous chloride, in quantity less than is required for saturation, thereby dissolving lead and silver chlorides, precipitating them, reconverting the solution into cupric chloride, using the same for leaching fresh quantities of ore, leaching the residues with a similar hot solution more concentrated in cupric chloride, thereby dissolving copper and recovering those metals therefrom, reconverting the resulting solution into cupric chloride, and returning the latter into the cycle of operations.

706436—August 5, 1902. F. T. Mumford. *Apparatus for the electrolytical treatment of ores or slimes.*

An apparatus for the extraction of metals from their ores and slimes, comprising a rotatable cylindrical metallic drum, a copper lining therein, a body of mercury in the drum to maintain the lining amalgamated, a valve-controlled inlet and outlet, and a relief valve at one end, a plurality of conductive rods insulated from and passing longitudinally through the drum, a metallic ring connecting the bars, trailing electrical contact for the drum and one for said ring.

709817—September 23, 1902. C. E. Dolbear. *Electrolytically treating ores.*

The method of reducing metals from their ores, which consists in dissolving the crushed ore in a compound containing a nitric acid radical, adding to the mixture sulphuric acid, and subjecting the resultant compound to the action of an electric current.

725863—April 21, 1903. W. B. McPherson. *Apparatus for the treatment of gold or other ores.*

A precipitating apparatus for depositing gold and silver from a cyanide of potassium solution and from other chemical solutions, comprising a precipitating box having downward, inclined bottom with openings therein, valves located in said openings, said box provided with a series of electric conducting plates vertically arranged therein and connected with a source of electric supply, a gauge receptacle, a pipe communicating with said receptacle and with the precipitating box through which the said solution passes back and forth, a float within said receptacle and adapted to reciprocate therein, a yoke secured to said float, a horizontally reciprocating valve rod, devices for connecting said yoke with said valve rod, means for operating said valves in connection with valve rod, and means for conveying said solution from said precipitating box and returning the same thereto.

737554—August 25, 1903. L. P. Burrows. *Electrolytic apparatus.*

An electrolytic apparatus, comprising a dissolving vessel having a revoluble anode, a depositing vessel having a cathode, means for conveying an unbroken stream of liquid from the dissolving vessel, and an electric circuit including said anode and cathode, whereby the electric current is caused to traverse the stream of liquid flowing from the dissolving vessel into the depositing vessel.

741231—October 13, 1903. W. H. Davis. *Process of treating cyanide solutions.*

The process for treating cyanide solutions during or subsequently to their contact with the ore, consisting in introducing into the solution an alkaline hydrate and then subjecting the mixture to the action of an alternating electric current, thereby raising the osmotic pressure to dissociate the double salts in the solution, causing precipitation of the hydrates of the base metals and to combine the freed cyanogen with the alkaline hydrates to cause simultaneous regeneration of the cyanide in the solution and clarifying of the latter.

741439—October 13, 1903. C. E. Baker and A. W. Burwell. *Process of treating ores.*

The process of recovering copper and nickel from a solution of sulphates of copper, nickel, and iron, which consists of electro-depositing the copper, neutralizing the solution, and electro-depositing the nickel with a current density insufficient to deposit the iron.

743668—November 10, 1903. R. Suchy and H. Specketer. *Extracting chromium from chrome-iron ore.*

The process of making soluble chrome-iron ore and obtaining chromium compounds, which consists in heating the ore together with sulphuric acid in excess and an oxidizing agent and separating by filtration the precipitated insoluble ferrisulphate from the chromosulpho acid.

749843—January 19, 1904. H. R. Cassel. *Process of extracting precious metals by electrolysis.*

The process of extracting precious metals by electrolysis, which consists in circulating the pulp between vertical electrodes, amalgamating a vertical cathode, successively deflecting the rebounding mercury back upon said cathode, removing the amalgam, neutralizing the alkali in the mercury, and returning the mercury to the cathode.

749844—January 19, 1904. H. R. Cassel. *Apparatus for extracting precious metals by electrolysis.*

An apparatus for extracting precious metals by electrolysis, comprising a tank, inclosed vertical electrodes, mercury deflectors, and pulp guards at the sides of the cathode, an elevated pulp box, communicating perforated launders, means for lifting the pulp into said box, an elevated mercury pot, communicating slidable perforated troughs, and means for lifting the mercury into said pot.

755302—March 22, 1904. E. A. Le Sueur. *Extraction of copper from comminuted mineral mixtures.*

The method of obtaining metallic copper from mixtures containing it, which consists, first in treating said mixtures with an ammoniacal solution containing a cupric compound or compounds, so as to dissolve the desired copper, then in removing a portion of the total copper contents of the solution, and lastly in using the partially exhausted solution over again to dissolve fresh copper as before.

QUICKSILVER

QUICKSILVER.

By Joseph Struthers, Ph. D.

The production of quicksilver in the United States during 1902 was confined to the states of California and Texas. In 1889 production was reported only from California and Oregon. Table 1 shows the comparable items for the census years of 1902 and 1889.

TABLE 1.—*Comparative summary: 1902 and 1889.*

	1902	1889
Number of mines	41	17
Number of operators	37	11
Salaried officials, clerks, etc.:		
Number	117	20
Salaries	$150,151	$31,966
Wage-earners:		
Average number	1,329	961
Wages	$881,340	$591,325
Contract work	$23,164	(1)
Miscellaneous expenses	$89,767	$85,490
Cost of supplies and materials	$322,867	$249,622
Product:[2]		
Total value	$1,550,090	$1,190,500
Quicksilver—		
Quantity, flasks	34,291	26,464
Value	$1,467,848	$1,190,500[3]
Cinnabar—		
Quantity, short tons	11,727	2,750
Value	$82,242	(1)

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[1] Not reported.

[2] The United States Geological survey reports $1,467,848, which does not include 11,727 short tons of cinnabar, valued at $82,242, mined but not reduced.

[3] Exclusive of 20 flasks, valued at less than $1,000, produced in Oregon.

The quantity of quicksilver produced in 1902 showed an increase of 29.6 per cent over that reported at the Eleventh Census. There were 11,727 tons of cinnabar reported, valued at $82,242, which was not reduced. The amount of mechanical power decreased 17 per cent. The growth in the number of wage-earners and in the wages paid them appears to have been normal. The increase in the amounts expended for supplies and materials, and for miscellaneous expenses also, is a normal growth.

Idle mines reported for 1902 numbered 56—50 in California, 3 in Oregon, and 3 in Texas. There were 10 operative mines for which no production was reported, the employees being engaged in development work. Seven of these mines were located in California and 3 in Oregon. The statistics for these nonproductive mines are summarized in the following statement. Among the owners of the idle mines and those for which development work was reported, were 7 incorporated companies, with a total par value of stock issued amounting to $10,683,000.

Development work: 1902.

Number of mines	10
Number of operators	9
Salaried officials, clerks, etc.:	
Number	8
Salaries	$9,525
Wage-earners:	
Average number	35
Wages	$27,498
Contract work	$150
Miscellaneous expenses	$955
Cost of supplies and materials	$7,169

Capital stock of incorporated companies.—Table 2, which follows, shows that 21 operators, or 56.8 per cent of the total number, were incorporated companies, and gives their capitalization.

TABLE 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	[1]21
Capital stock and bonds issued	$39,017,700
Capital stock:	
Total authorized—	
Number of shares	2,222,620
Par value	$44,100,000
Total issued—	
Number of shares	2,136,143
Par value	$38,872,700
Dividends paid	$171,994
Common—	
Authorized—	
Number of shares	2,179,620
Par value	$39,800,000
Issued—	
Number of shares	2,093,143
Par value	$34,572,700
Dividends paid	$150,494
Preferred—	
Authorized—	
Number of shares	43,000
Par value	$4,300,000
Issued—	
Number of shares	43,000
Par value	$4,300,000
Dividends paid	$21,500
Bonds:	
Authorized—	
Number	1,450
Par value	$145,000
Issued—	
Number	1,450
Par value	$145,000
Interest paid	$6,000
Assessments levied	$173,500

[1] Includes 18 in California and 3 in Texas.

The par value of capital stock, common and preferred, and of bonds issued, amounted to $39,017,700. This seems excessive for an industry producing a product valued at only $1,550,090. The dividends paid on the stock were small, amounting to $150,494 on the common and $21,500 on the preferred. The interest paid on bonds was $6,000. The dividends paid on the common stock amounted to four-tenths of 1 per cent of the par value of all common stock issued. The dividend on the preferred stock was five-tenths of 1 per cent on the total amount issued.

Employees and wages.—The average number of wage-earners employed each month, as given in Table 8, was remarkably uniform, varying only from 1,303 in July and August to 1,358 in November, a difference of 55. In this respect the industry presents a uniform operation, due to the fact that the demand for cinnabar and mercury is steady, and that the mines reported were located in California and Texas, where the climate permits of uninterrupted working. Child labor is relatively unimportant, amounting to about one-half of 1 per cent of the whole number of wage-earners.

The daily rates of pay at which the workmen engaged in the various occupations were employed are also given in Table 8. Miners constituted 46.2 per cent of the total number of wage-earners, and of all miners 75.4 per cent were employed at rates not less than $1.75 per diem. Of the 38 engineers reported, all received $2 or more per diem, and the same is true of 35 out of the total of 42 firemen. Miners' helpers formed an important class, constituting 17 per cent of the total number of wage-earners. These workmen had various duties and their rates of pay ranged from 75 cents to $2.99 per diem. The timbermen and track layers received good wages, 11 receiving from $2 to $2.24, and 7 from $3 to $3.24 per day. The class "all other wage-earners" is chiefly composed of ordinary laborers. Of these workmen 43.7 per cent received less than $2 per diem, while 56.3 per cent received $2 or more.

Mechanical power.—Primary power aggregating 1,808 horsepower was reported. This was applied chiefly through steam engines, of which there were 56 reported, or an average horsepower of 28. Over 8 per cent of the total power was furnished by 17 gas or gasoline engines. Three water wheels were reported, representing 22 horsepower. Sixty horsepower was supplied by 5 air compressors. There were also 3 electric motors with 15 horsepower.

Production in the United States.—The quicksilver produced in the United States during 1902 amounted to 34,291 flasks of 76.5 pounds each, aggregating 1,189.9 metric tons, and valued at $1,467,848, as compared with 26,464 flasks, 918.3 metric tons, valued at $1,190,500 in 1889. This shows an increase in quantity of 7,827 flasks, and in value of $277,348, over the statistics at the Eleventh Census.

Mercury is transported in cylindrical wrought iron flasks, each 5 inches in diameter and about 14 inches long, closed with a screw plug, and having a capacity in the United States of 76.5 pounds. At Almaden, Spain, and Idria, Austria, the capacity is slightly less, being 76 pounds.

Of the 34,291 flasks produced in the United States during 1902, California contributed 28,972 flasks, or 84.5 per cent, and Texas 5,319 flasks, or 15.5 per cent. Except as noted below, the entire output of quicksilver in the United States has been derived from California, and statistics of production and the average value per flask for that state during the period from 1889 to 1902, inclusive, are given in Table 3, as reported by the United States Geological Survey. In addition to the output of California, the following quantities have been produced in Texas and Oregon: Texas, in 1899, 261 flasks; in 1900, 750 flasks; in 1901, 2,932 flasks; and in 1902, 5,319 flasks; Oregon, in 1900, 233 flasks and in 1901, 75 flasks.

TABLE 3.—*Production of quicksilver in California and the average price per flask at San Francisco: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	Quantity (flasks each containing 76.5 pounds).[1]	Average price per flask.
1889	26,464	$45.00
1890	22,926	52.50
1891	22,904	45.25
1892	27,993	40.71
1893	30,164	35.75
1894	30,416	30.70
1895	36,067	37.04
1896	30,765	34.96
1897	25,691	37.28
1898	31,092	38.23
1899	29,454	47.70
1900	26,317	44.94
1901	26,720	48.46
1902	28,972	43.20

[1] Beginning with 1893, figures taken from Annual Statistical Bulletin of the California State Mining Bureau.

Prices.—The price of quicksilver in the United States is affected by several conditions, chiefly the quantity available and the mode of disposition of the product, whether for home consumption or for export. In the latter case a relatively low price is obtained for the metal, as it has to compete in foreign markets with the European product. In some cases the prices vary according to the rates of transportation from the various entry ports to the points of consumption, in order to compete with the European product which may enter at other ports; thus, comparatively higher export prices are obtained at western coast ports of Mexico than at interior points of consumption adjacent to railroads leading to eastern ports.

The average monthly price of quicksilver, per flask, during 1902, as reported by the United States Geological Survey, is given in Table 4. The lower averages during 1902 indicate the periods of largest sales for export, and the higher averages indicate periods of sales for domestic consumption.

TABLE 4.—*Average monthly price of quicksilver per flask at San Francisco during 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

MONTH.	Price	MONTH.	Price
January	$45.30	August	$42.71
February	44.29	September	42.35
March	45.56	October	42.37
April	45.00	November	42.61
May	44.83	December	45.00
June	45.77		
July	45.69	Average	44.10

The average monthly price of quicksilver, per flask, at New York during 1902 was $48.37 for January, and $48 for the other months of the year.

Imports and exports.—The quantity of quicksilver imported during the past decade has been inconsiderable, owing to the fact that in this period approximately one-half of the domestic product has been exported. For the past five years the quantities imported have been merely nominal.

Table 5, published by the United States Geological Survey from statistics of the United States Treasury Department, shows the quantity and value of the annual imports of quicksilver from 1889 to 1902, inclusive, and Table 6, from the same source, shows the quantity and value of the exports of quicksilver during the period 1889 to 1902, inclusive. Prior to 1901 very nearly the entire quantity of quicksilver exported was shipped from San Francisco, but in that year only 5,479 flasks of the total of 11,219 flasks exported were shipped from that port, practically the entire exportation being consigned to Mexico and Central America.

TABLE 5.—*Quicksilver imported and entered for consumption in the United States: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING DECEMBER 31—	Quantity (pounds).	Value.
1889	341,514	$162,064
1890	802,871	445,867
1891	123,966	61,355
1892	96,318	40,133
1893	41,772	17,400
1894	7	6
1895	15,001	7,008
1896	315	118
1897	45,592	20,147
1898	81	51
1899	131	83
1900	2,616	1,061
1901	1,441	789
1902	(1)	2,166

[1] Not stated.

TABLE 6.—*Exports of quicksilver from the United States: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (flasks).	Value.
1889	5,111	$213,717
1890	2,069	83,192
1891	3,714	145,502
1892	3,518	133,626
1893	16,631	542,410
1894	11,408	397,528
1895	15,732	492,065
1896	19,914	618,437
1897	13,173	394,549
1898	12,830	440,587
1899	16,517	609,586
1900	10,172	425,812
1901	11,219	475,609
1902	13,217	575,099

Production in the principal producing countries of the world.—The following table gives the production, in metric tons, and the value of quicksilver in various countries in the years 1899, 1900, and 1901, as reported by the United States Geological Survey:

TABLE 7.—*World's production and value of quicksilver in 1899, 1900, and 1901.*[1]

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Metric tons.]

COUNTRY.	1899		1900		1901	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	1,057	$1,452,745	983	$1,302,586	1,031	$1,382,305
Austria	536	492,021	510	499,052	525	547,513
Italy	205	246,000	260	312,000	278	361,400
Russia	362	321,814	304	270,256	(2)	(2)
Spain	1,361	1,481,229	1,095	1,193,550	754	1,105,890
Total	3,521	3,993,809	3,152	3,577,444	2,588	3,397,108

[1] Mexico exported 324 tons of quicksilver in 1899, 335 tons in 1900, and 335 tons in 1901.

[2] Statistics not yet available.

A detailed summary showing the statistics for quicksilver during 1902 is given in Table 8.

DESCRIPTIVE.[1]

Historical.—Mercury or quicksilver has been known to mankind from very early times. No mention of it appears, however, in the books of Moses or in the works of the early Greek writers. The earliest known reference is in the writings of Theophrastus (300 B. C.), who speaks of liquid silver or quicksilver. Dioscorides refers to artificial mercury as ὑδράργυρος, water silver; Pliny gave it the name of *hydrargyrum* in contradistinction to native mercury, which he called *argentum vivum*. The name quicksilver was undoubtedly suggested by the liquid form and silver color of the metal, while that of mercury was derived from the name of the Greek god Mercury, probably in allusion to the quickness and ease with which it flows in any direction. The salts of mercury also were known at a very remote period. The early Arabians were familiar with mercurous chloride (Hg_2Cl_2), or calomel, and mercuric oxide (HgO), the red oxide, and the alchemists possessed a knowledge of mercuric chloride ($HgCl_2$), corrosive sublimate. The mineral cinnabar, mercuric sulphide, has been used as a pigment from the most ancient times on account of its enduring vivid red color. By reason of its peculiar physical properties in being liquid, very heavy, and not acted on by air, sulphuric acid, or hydrochloric acid, mercury perhaps more than any other metal has excited the attention and curiosity of experimenters.

Physical and chemical characteristics.[2]—The symbol of mercury (Hg) is derived from the old Latin name *hydrargyrum*. Its atomic weight is 199.8. Aside from bromine, mercury is the only elementary metal which exists in a liquid form at ordinary temperatures. It is a bright tin-white liquid, and, when free from impurities, the globules retain a perfectly spherical shape. The luster is mirror like, and like that of silver it is preserved in air free of sulphurous gases. Mercury, when cooled to a temperature of −38.8° C., is transformed into a tin-white, ductile, malleable mass, softer than lead and crystallizing in octahedrons. During the cooling it contracts uniformly until the temperature of solidification is reached, at which point a considerable contraction takes place, and, as a consequence, the solidified mercury will sink below the surface of liquid mercury. At 0° C. the specific gravity of mercury is 13.596 and at −38.8° C. the specific gravity of solidified mercury is 14.193. In very thin films the liquid metal is transparent and of a violet-blue color when viewed by transmitted light.

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[1] In this paper the older term "quicksilver" has been retained for use in connection with the description of the mining and metallurgy of the metal, as it is the name generally accepted by the public. The modern name "mercury" has been reserved for the description of the physical and chemical properties of the metal.

[2] Inorganic Chemistry, Newth, page 554 ff.

The specific heat of solidified mercury (between −78° C. and −40° C.) is 0.0247; that of liquid mercury (between 0° C. and 100° C.) is 0.0333. Its thermal conductivity is 667, compared with that of silver taken at 1,000, and its electrical conductivity at 22.8° C. is 1.63, silver at 0° C. being taken at 100.

The boiling point of mercury at the standard pressure of 760 mm. is 357.25° C. Above this temperature it becomes a transparent, colorless vapor, having a density of between 6.7 and 7.03, referred to air as a unit. The density of gaseous mercury compared with hydrogen is 100.92, and as its atomic weight is 199.8, this element in a gaseous form consists of monatomic molecules. Mercury gives off vapors at all temperatures. This may be illustrated by suspending a piece of gold leaf above the surface of mercury in a stoppered bottle; the gold leaf will slowly assume a white color from the formation of gold amalgam on the surface.

In its liquid and gaseous forms mercury is poisonous, producing salivation when taken either internally through the lungs or stomach or by absorption through the pores of the skin. Mercury is not tarnished by exposure to the air, nor is it acted on by many gases; hence it is an invaluable aid to the chemist in the collection and measurement of gases which are soluble in or absorb water. When subjected to prolonged heating in the air, mercury is slowly transformed into red mercuric oxide (HgO), which at a higher temperature is again decomposed into its elements—mercury and oxygen.

Liquid mercury is converted by agitation with oil or by trituration with sugar, chalk, or lard into a dull-gray powder. This process is called "deadening," and is used to prepare mercurial ointment, the gray powder consisting simply of very finely divided mercury in the form of minute globules.

Mercury is not attacked by hydrochloric acid. Concentrated sulphuric acid has no action on it in the cold, but rapidly dissolves it when heated, yielding sulphur dioxide gas. Diluted nitric acid dissolves it slowly when cold, forming mercurous nitrate, and concentrated nitric acid attacks it rapidly, forming mercuric nitrate and fumes of oxides of nitrogen.

In commerce mercury is usually contaminated with a small proportion of dissolved metals, which cause a globule to lose its spherical shape and drag a tail behind it while flowing over an inclined surface. If the mercury is shaken in the air, these metallic impurities become oxidized and form a black powder or scum, which incloses small drops of the metal, thus preventing them from coalescing. Mercury in this condition is said to be "floured." Commercial mercury is best purified by distillation, but for ordinary purposes the impurities may be removed almost entirely by repeated agitation with dilute nitric acid or perchlorate of iron, either of which attacks the impurities and forms with them soluble nitrates and chlorides, respectively, which are removable by washing with water.

Occurrence.—Mercury is found in nature chiefly as the ore cinnabar, mercuric sulphide (HgS or Hg_2S_2). It occurs also, though less commonly, as native mercury, which is disseminated in many cinnabar deposits in the form of fine globules, sometimes in large quantities. From a commercial standpoint, cinnabar and metallic mercury are the only ores of importance.

The following is a list of all the known ores of mercury, classified according to composition:

List of the mercury ores.

Class.	Mineral name.	Composition.
Native mercury	Native mercury	Hg
Amalgams (silver)	Amalgam	$AgHg$ or Ag_2Hg_3
	Arquerite	$Ag_{12}Hg$
	Kongsbergite	$Ag_{36}Hg$
Amalgams (gold)	Gold amalgam	$(Au,Ag)_2Hg_3$
Sulphides	Cinnabar	HgS or Hg_2S_2
	Metacinnabarite	HgS or Hg_2S_2
	Hepatic cinnabar or liver ore	HgS or Hg_2S_2, with carbon and clay
	Livingstonite	$HgS.2Sb_2S_3$
	Ammiolite	$HgSb,Cu,S$ and Fe
	Barcenite	$HgSb,S$ and Fe
Sulpho-selenides	Onofrite	$Hg(S,Se)$
	Guadalcazarite	$Hg(S,Se)$
	Leviglianite	$Hg(S,Se)$ with Fe
Selenides	Tiemannite	$HgSe$
	Lehrbachite	$(HgPb)Se$
Tellurides	Coloradoite	$HgTe$
	Magnolite	Hg_2TeO_4
Chloride	Calomel	Hg_2Cl_2
Oxychlorides	Terlinguaite	Hg_2ClO
	Eglestonite	Hg_4Cl_2O
Iodides	Coccinite	HgI
	Tocornalite	$(HgAg)I$
Oxide	Montroydite	HgO

Important compounds of mercury.—With most metals mercury forms a series of alloys called amalgams; in some cases, as with the alkali metals, the formation of the alloy is attended with a rise of temperature, while in other cases, as with tin, an absorption of heat results. Sodium and potassium amalgams are decomposed by contact with water, yielding hydrogen gas and an alkaline hydroxide; for this reason sodium amalgam is used in the laboratory as a reducing agent. Zinc amalgam is acted upon very slowly by dilute sulphuric acid, and on this account the surface of zinc plates in galvanic batteries is usually amalgamated. Tin amalgam is used to produce the reflecting surface of ordinary mirrors, and amalgams of gold, copper, and zinc are used in dentistry as fillings for teeth.

In addition to the amalgams, mercury forms the following commercially important compounds: With chlorine, mercurous chloride ($HgCl$), or calomel, largely used in medicine, and mercuric chloride ($HgCl_2$), or corrosive sublimate, used in medicine, and in surgery as an antiseptic, and also in the preparation of anatomical specimens, and in the dressing of furs and skins; with oxygen, mercurous oxide (Hg_2O), the suboxide or gray oxide of mercury which is of little importance commercially, and mercuric oxide (HgO), the red oxide of mercury or red precipitate, used in medicine and for various purposes in chemical analyses; with sulphur, cinnabar, mercuric sulphide (HgS), or vermilion, the same as cinnabar, the chief ore of mercury. Vermilion is invaluable as a pigment, because of the permanence of its vivid cochineal-red color. It is made artificially in two ways—one, termed the dry method, in which an intimate mixture of metallic mercury and sulphur in proper proportions is heated in a retort and the sublimed product condensed and ground very fine, the beauty of the tint depending largely upon the fineness of the material; and the other, called the wet method, by which various compounds of mercury are transformed into the sulphide by the use of chemical reagents. Vermilion prepared by the wet method is of better quality than that made by the dry process. The manufacture of vermilion has declined in recent years on account of the competition of cheaper pigments which have supplanted its use. The most important of these is "orange mineral" (red lead), which is toned up to the proper color by the use of eosin, one of the aniline dyes. These imitation vermilions are now employed for almost all of the more common uses, such as wagon painting, and while they are inferior to the true mercury vermilion, from the fact that they fade on exposure, yet they are a fairly satisfactory substitute as long as they are protected by an exterior coating of varnish. Mercury vermilion is now used chiefly for red colors in oil paintings, lithography, etc.

The extraction of mercury from its ores.—Mercury is extracted by heating the ore in a retort or a furnace; the metal is expelled as a vapor, which is subsequently condensed in cooling chambers and collected.

Up to the present time mercury has been extracted from its ores solely by the dry process. Various chemical and electrolytic methods have been proposed repeatedly and numerous experiments made, but without commercial success.

Perhaps the development of electric current generated by waterpower in localities where the use of fuel is nearly or quite prohibitive will render profitable the extraction of the metal by some electrolytic process.

The principal ore of mercury, as already stated, is cinnabar, mercuric sulphide, accompanied at times with minute globules of native mercury. The metal may be extracted from the ore by a simple distillation, either in a retort or in a shaft furnace, and though mercury may be separated from cinnabar in numerous ways, only two methods are now used on a large scale. One is based on the decomposition of the ore at a high temperature by air, forming metallic mercury and sulphur dioxide gas in accordance with the reaction: $HgS+O_2=Hg+SO_2$ (360° C.). The other accomplishes the decomposition by the use of lime or iron which combines with the sulphur and sets free the mercury in accordance with the reactions: $4HgS+4CaO=4Hg+3CaS+CaSO_4$, and $HgS+Fe=FeS+Hg$, respectively. These chemical decompositions take place at temperatures above the boiling point of mercury so that the latter is expelled in gaseous form and subsequently condensed and collected in cooling chambers.

In present furnace practice the heat necessary for the decomposition of the ore, either with or without the admixture of lime or iron, is applied in two ways—first, by heating the ore charge in a tightly sealed iron retort, which produces the mercurial vapor undiluted with furnace gases; and second, by treatment in a large furnace, where the products of combustion come in direct contact with the ore and pass out of the furnace in the form of sulphur dioxide gas, nitrogen, and unused air, mixed with the expelled mercurial gases, from which the metal is obtained by condensation in the cooling chambers. Thus the essential difference between the two methods is that the vapors given off in the retort furnaces are entirely separate from the furnace gases of combustion. The retort method possesses the advantage of yielding the mercurial vapor in a concentrated and easily condensible form, which is more than offset, however, by the high cost of fuel and labor involved and the small size of a single charge. At present the use of iron retorts is restricted to exceptionally rich ores and mercurial soot and concentrates.

The furnaces now generally used in California are of the shaft type, into which the ore is fed continuously. There are two kinds of these furnaces—one called the "coarse-ore" furnace, used for treating lump ore, and the other the "tile" furnace for medium-sized and fine ores. There are many differences in the details of the construction of coarse-ore shaft furnaces, but in general they consist of a cylindrical brick shaft, into which the ore is charged at the top, while the cinders are removed at the bottom. The heat necessary for the reaction is supplied at or near the bottom of the shaft, the gases of combustion passing through the ore column, and, together with the liberated mercurial vapors, pass out from the furnace through a pipe at the top and are led to the condensing plant. The general type of tile furnace consists of a number of narrow rectangular shafts, each having a series of tiles inclined inward and downward and so placed alternately on the longer sides that the fine to medium sized ore (up to 3.5 inches in diameter) will follow a zigzag path in its descent, until it is finally discharged at the bottom through the drawing pit. The ore is gradually heated in its descent by the products of combustion from the fuel burned in the fireplaces at or near the bottom of the furnace.

The condensing plant generally consists of a cooling device and a condensing chamber in which the liquefied mercury is deposited. The gases passing out from the furnace must necessarily be of a temperature higher than the boiling point of mercury (357.25° C.), and the mercury content of these gases by volume is often less than 1 per cent. In addition to the products of combustion of the fuel and the mercurial vapors, these furnace gases contain sulphur dioxide, which is derived from the decomposition of the ore, which when cooled yields acid liquors that attack ordinary materials of construction. In the construction of the condensing apparatus for the proper cooling and condensation of the mercury three factors must be taken into consideration: The distance the gas has to travel, the interior capacity of the chamber, and the area of the cooling surface. The details of adjusting the construction of the condenser to give the best results vary at each plant. The materials used in building the condensers should be nonabsorbent of mercurial vapor, good conductors of heat, not affected by acid vapors or liquors, and capable of being molded into the required form. No one substance answers all requirements. Iron is a good conductor of heat and may be easily shaped, but it does not resist the corrosive action of the acid vapors, and to overcome this disadvantage the iron pipes are often protected from corrosion by a coating of cement. Brick absorbs mercurial vapors, is attacked by acids, and is a bad conductor of heat. Wood will resist acid, but is a bad conductor of heat, and can not be placed near the furnace where the temperature of the gases is high. Glazed stoneware resists the action of acid and mercury, and may be made thin in order to offset its poor heat-conducting qualities. As with the variations in the selection of the materials of construction used, so is it with the general arrangement of the condensing plant.

Uses.—The most important commercial use of mercury is in the extraction of gold and silver from certain ores by the amalgamation process; the precious metals becoming alloyed with the mercury, form a heavy amalgam, which is separated by gravity from the fine sands and the "tailings" of the ore suspended in water. Owing to the avidity with which mercury combines with impurities, thereby becoming subdivided into innumerable minute globules which will not coalesce, considerable quantities of the metal are lost during the amalgamation process, by being held in suspension in the water, and washed away with the sands and the tailings.

In the chemical industries large quantities of mercury are used as electrodes in several electrolytic processes, notably in the electrolysis of brine to form sodium salts. The solution of salt having been decomposed by the electric current, the metallic sodium thereby set free at the cathode immediately combines with the mercury, from which the sodium is subsequently extracted by a treatment with water, forming sodium hydroxide (caustic soda). On account of its high specific gravity, and its freedom from attack by many gases, mercury is an invaluable material for the construction of liquid seals in gas collecting apparatus, for making thermometers and barometers, and for making electrical contacts in certain apparatus used in physical laboratories and industrial processes.

REVIEW OF THE QUICKSILVER INDUSTRY IN THE UNITED STATES DURING 1902.

The quicksilver deposits of commercial importance in California are situated in the Coast Range and are limited to an area bounded by Trinity county on the north and San Luis Obispo county on the south, both counties being included. During 1902 San Benito county contributed 7,289 flasks, valued at $306,096, the product being derived largely from the New Idria mine. Development work was carried on during the year at the Cerro Benito and the Pichaco mines. In Napa county the chief producer was the Napa Consolidated mine at Oat Hill. In the Knoxville district the Boston mine, formerly the Readington mine, under the control of the Boston Quicksilver Mining Company, and the Manhattan mine contributed to the output. The total production for Napa county during the year amounted to 7,300 flasks. Santa Clara county was next in the order of quantity produced, contributing 5,779 flasks. The chief producer in this county was the New Almaden mine, followed by the Guadalupe mine. The New Almaden mine is the oldest quicksilver mine in the United States. It was discovered and worked in 1824, when California was under Mexican rule, and was then known as the Chaboya mine. Later it was abandoned until 1845, and since 1850 it has been worked continuously. Furnaces were erected at the Santa Teresa and the Summit mines. San Luis Obispo county supplied 2,546 flasks, the chief producer being the Karl Quicksilver Mining Company. A new Scott furnace was installed and put in operation at the Oceanic mine, and development work was actively carried on at a number of smaller properties, notably the Alice, Modoc, Libertad, Madrone, Pine Mountain, and Stayton mines. Lake county furnished 3,797 flasks, obtained chiefly from the Great Western mine. The Sulphur Bank and Abbott mines, controlled by the Empire Consolidated Quicksilver Mining Company, were in litigation during the year. The Helen mine furnished a small quota, and promising development work was done at the Bullion mine, operated by the Standard Company. From Colusa county a considerable product was obtained from the Manzanite mine, Sulphur creek, where a successful process of ore concentration was operated. In Sonoma county the chief producer was the Great Eastern Quicksilver Mining Company. The total output of the county during the year was 1,519 flasks. A number of old mines were reopened in the Pine Flat district. Other producing mines were the Cloverdale, the Great Western, and the Socrates. Development work of the Pacific Company on property adjoining that of the Crystal Company was so satisfactory as to warrant the erection of a furnace to treat the ore. A new modified Livermore furnace was completed at the Culver Bear property. In Trinity county, which contributed a small amount to the total output during the year, the Altoona Company treated ore from the surface workings and the dumps. Considerable development work was accomplished by the Boston, Integral, and several minor concerns. The balance of the total output of California was obtained in Solano county. Several new mines were added to the list of producers during 1902; those contributing an output of 100 flasks or more being the Helen mine in Lake county, and the Silver Creek mine in Santa Clara county. Other quicksilver companies reported to have started operations in 1902 were the Monterey Quicksilver Mining Company, near Idria, San Benito county; the Modoc Chief mine, near Redding, Shasta county; the Mariposa and Elizabeth mines, and the Uncle Sam and Eureka mines, near Cambria, San Luis Obispo county; and the Summit, Adobe Valley, and Orestimba properties, in Stanislaus county. A deposit of quicksilver ore of good quality was reported in Modoc county, 25 miles east of Cedarville, in the extreme northwestern part of the state—an entirely new section for the occurrence of cinnabar.

As to the future of the quicksilver mining industry of California the larger and better known mines have in a measure been worked out, and it is hardly within the range of probability that other mines equal in extent to the New Almaden or the New Idria will be discovered. Yet, on the other hand, there are many smaller mines which, by contributing from 20 to 300 flasks each per month, supply a considerable quantity of metal in the aggregate. Furthermore, the improvement in metallurgical and mining practices during recent years, which permits the profitable treatment of very lean ores, will probably maintain the quicksilver industry in an important economic position for many years to come. It is stated in general that quicksilver can be produced in California at a mining and smelting cost of $3 per ton of ore, which renders it possible to treat with profit ores containing from 0.3 to 0.6 per cent of quicksilver; in a few cases it is possible to treat even lower grade ores and yet make a profit. The general statement is made that a modern furnace, operating on average ores, produces quicksilver at a cost of $35 per flask not including interest on capital invested in the plant and property, or the cost of development work at the mine.

In Oregon the sole producer of quicksilver in recent years has been the Black Butte Quicksilver Mining Company, which opened a quicksilver mine in 1898 on a spur of the Cascade mountains at Black Butte, Lane county. A modern 40-ton shaft furnace of the inclined shelf type was installed, but after a few months it was closed for alterations, the condensation of the quicksilver being too imperfect to render the smelting profitable. Operations were resumed in 1900. In that year the above-named company acquired the Elkhead mine, in Douglas county, 5 miles from Black Butte; this mine was equipped with a 10-ton Scott furnace. Considerable development work has been reported by this concern, but the operations have not been entirely successful, as only 75 flasks of quicksilver were produced in 1901 and none in 1902. The ore of the Black Butte mine is of low grade, the average rarely exceeding one-half of 1 per cent of quicksilver.

The principal operating companies in Texas in 1902 were the Marfa and Mariposa Mining Company, with three 10-ton Scott furnaces; the Terlingua Mining Company, with one 40-ton Scott furnace; and the Colquit-Tigner Mining Company, with one 10-ton Scott furnace.

The cinnabar deposits of California Hill, Brewster county, near Terlingua post-office, 90 miles southeast of Marfa, were known to the Comanche Indians, who used them as a vermilion pigment. The knowledge of these deposits, however, was not recorded until 1894, when several Mexicans found a few pieces of cinnabar float and took them to San Carlos, on the Mexican side of the Rio Grande, whence they were sent to Chihuahua, and their mineralogical character determined. Mr. George W. Wanless, of the Rio Grande Smelting Works, and Mr. Charles Allen, of Socorro, N. Mex., under the direction of the Mexicans, found the veins and located the first mineral claims. Shortly after this Prof. William P. Blake described these deposits under the title "Cinnabar in Texas,"[1] the first important article concerning this subject on record. Considerable prospecting work was carried on in the district, but it was not until 1898 that the metal was produced in commercial quantities. In that year Lindheim & Co. made a few flasks of quicksilver in a crude furnace at Terlingua. Other concerns became interested in the development of the quicksilver deposits, and the output of the region was 270 flasks in 1899, 750 flasks in 1900, 2,932 flasks in 1901, and 5,319 flasks in 1902, thus making a total output of 9,271 flasks.

The deposits of cinnabar at Terlingua are of two classes; one occurs in hard and durable limestone and the other in soft and friable argillaceous beds. The ores are cinnabar, mercury, yellow sulphide, and terlinguaite, and contain in addition several other mercury minerals, such as calomel, eglestonite, and montroydite, which, on account of their rarity, are of scientific interest only. Cinnabar is the principal mineral and is usually mixed with clay or iron oxide. Native mercury is present in several localities in the district, occurring in the interstices of crystalline calcite, and a single cavity in the calcite veins has yielded as much as

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXV (1895), pages 68 to 76.

20 pounds of the native metal. The associated gangue is composed of calcite, aragonite, gypsum, and occasionally a little barite; iron oxide, pyrite, and occasionally arsenic and manganese minerals.

The methods of mining in the Terlingua district up to the present time have been extremely crude. The workings have been confined mainly to the open cuts on the surface, but a few shafts have been sunk to a depth of from eighty to ninety feet and the ore obtained by drifting along the vein. The material mined is carried to the surface in rawhide buckets on the backs of Mexican miners, who climb notched-pole ladders with great agility. The veins are generally quite narrow, often less than one foot in width. The mined ore is sorted by hand, arranged into piles according to richness, and transported to the furnace plant, where it is first crushed in a Blake crusher, operated by gas engines, which are more convenient than steam engines on account of the lack of water and fuel. The crushed ore is then conveyed to the ore bins, which are situated above the level of the furnace, and from there, as required, it is dumped into cars and charged into the furnace through hoppers.

Formerly the very rich ore was treated in a retort, a method so wasteful and entailing such costly repairs that it has been supplanted almost entirely by shaft furnaces of the continuous type similar to the Scott-Hüttner furnace used in California. The greater part of the ore is treated in a shaft furnace by air oxidation, in some cases lime being added to aid in the decomposition of the sulphide. A very small proportion, consisting of extremely rich pieces, is treated in a furnace of the retort type.

The development of the quicksilver mines in this region has been seriously hampered by the scarcity of water and the lack of fuel, mesquite wood being about the sole supply of the latter. However, coal and asphaltum have been found within a few miles of Terlingua, and there is a possibility that oil may be discovered, as the formation closely resembles that of the Corsicana oil fields.

THE QUICKSILVER INDUSTRY IN FOREIGN COUNTRIES.

In Spain, 90 per cent of the total production of quicksilver is obtained from the Almaden mines, in the province of Ciudad Real, which have been worked intermittently during the past two thousand years. The mines are owned by the Government, and the output is controlled by the Rothschilds, who have been operating the mines under a ten-year concession, which was continued in 1900. The ores are very rich, averaging about 8 per cent of metal. The furnaces are not operated during the hot season, from May to September. Mining is conducted with a view to permanency, and masonry is freely used in the various galleries and chambers of the mines. It was not until 1896 that machine drills were installed.

In Austria, the cinnabar deposits of Idria, in Krain, were first mined in 1490, and shortly afterwards were placed under Government ownership and supervision. These mines furnish by far the greater part of the total output of quicksilver in Austria, only a small quantity being supplied by the mines in Hungary. The ore of the Idria mines is separated by hand into three classes, namely, (1) a small proportion of high grade ore, containing about 8.5 per cent of mercury; (2) coarse ore, containing about thirty-five hundredths of 1 per cent of mercury; and (3) fine ore, containing sixty-five hundredths of 1 per cent of mercury. In recent years the annual average content of the concentrated ore treated in the furnaces has varied from seventy-five hundredths of 1 per cent to 1 per cent of mercury.

In Russia, the entire output of quicksilver is obtained from the mines of A. Auerbach & Co., situated near Nikitovka, on the Kursk-Kharkov Railroad, government of Ekaterinoslav, in the southern part of European Russia. In ancient times these deposits were exploited by the Greeks, but the present industry was not inaugurated until 1883. The average content of mercury in the ores extracted approximates four-tenths of 1 per cent.

In Italy, the important quicksilver producers are the Castelazara and Ripa mines in the Monte Amiata district, and the Vallalta mine in the province of Venice. The mines at Monte Amiata were originally worked by the Etruscans, and active operations are on record for the period from 1000 to 1200 A. D. The present industry began at Siele in 1846 and at Carnucchi in 1879. The ores average from three-tenths to six-tenths of 1 per cent of mercury and are treated in furnaces of modern construction. A detailed description of the furnace practice at Monte Amiata is published in The Mineral Industry, Vol. VI, pages 576 to 582.

In Mexico, the principal quicksilver producers are the Huitzuco mines, 50 miles north of Tixtla, in the state of Guerrero, and the mines at Guadalcazar. The Huitzuco deposits were first exploited in 1874 and since 1885 they have contributed annually an output of from 2,000 to 3,000 flasks of quicksilver. The ores average from six-tenths of 1 per cent to 1 per cent of mercury, and the cost of labor and fuel is so small that ores averaging as low as three-tenths of 1 per cent of the metal can be treated profitably. The methods of mining and smelting are very primitive, and the amount of metal extracted by the furnace treatment rarely exceeds one-half of the quantity present in the ore. The mines at Guadalcazar, 70 miles northeast of San Luis Potosi, have been worked by two concerns, the Compañía de Minas de Azogue de Guadalcazar and the Compañía de Nueva Potosí. The ores in this district, which contain an average of from 2 to 3.5 per cent of mercury, are smelted in a retort furnace provided with dust boxes, condensers, and a number of brick settling chambers equipped with baffle plates. The smelting process is primitive and wasteful, yet labor and fuel are so cheap that the operations are carried on with financial profit. The old mines, worked by the Nueva Potosi Company, are reported to contain immense bodies of easily accessible cinnabar ore, carrying an average of 1 per cent of mercury. The plant of this company is equipped with two 6-ton furnaces.

In China, Australia (New South Wales), Algeria (Taghit), Brazil, Peru, and Colombia deposits of cinnabar have been reported from time to time, but in general, because of the inaccessibility of the various districts in which the deposits are located, they still await development. A small output of quicksilver was obtained early in 1902 by an English company operating the cinnabar deposits in the province of Kweichau in southwestern China.

Table 8 shows in detail the statistics of the quicksilver industry for 1902.

TABLE 8.—*Detailed summary: 1902.*

Number of mines	41
Number of operators	[1]37
Character of ownership:	
Individual	9
Firm	7
Incorporated company	21
Salaried officials, clerks, etc.:	
Total number	117
Total salaries	$154,164
General officers—	
Number	16
Salaries	$29,650
Superintendents, managers, foremen, surveyors, etc.—	
Number	54
Salaries	$85,634
Foremen below ground—	
Number	20
Salaries	$20,230
Clerks—	
Number	27
Salaries	$18,650
Wage-earners:	
Aggregate average number	1,329
Aggregate wages	$881,340
Above ground—	
Total average number	472
Total wages	$329,980
Engineers, firemen, and other mechanics—	
Average number	189
Wages	$118,458
Miners—	
Average number	31
Wages	$46,217
Boys under 16 years—	
Average number	4
Wages	$1,145
All other wage-earners—	
Average number	248
Wages	$169,160
Below ground—	
Total average number	857
Total wages	$551,360
Miners—	
Average number	533
Wages	$382,526
Miners' helpers—	
Average number	226
Wages	$124,464
Boys under 16 years—	
Average number	4
Wages	$620
All other wage-earners[2]—	
Average number	94
Wages	$43,750
Average number of wage-earners at specified daily rates of pay:	
Engineers—	
$2.00 to $2.24	2
$2.25 to $2.49	7
$2.50 to $2.74	18
$2.75 to $2.99	5
$3.00 to $3.24	6
Firemen—	
$1.50 to $1.74	3
$1.75 to $1.99	4
$2.00 to $2.24	9
$2.25 to $2.49	15
$2.50 to $2.74	11
Machinists, blacksmiths, carpenters, and other mechanics—	
$1.25 to $1.49	1
$1.50 to $1.74	5
$1.75 to $1.99	1
$2.00 to $2.24	8
$2.25 to $2.49	11
$2.50 to $2.74	12
$2.75 to $2.99	3
$3.00 to $3.24	15
$3.25 to $3.49	2
$3.50 to $3.74	1
Miners—	
$1.00 to $1.24	32
$1.25 to $1.49	105
$1.50 to $1.74	11
$1.75 to $1.99	94
$2.00 to $2.24	20
$2.25 to $2.49	77
$2.50 to $2.74	219
$2.75 to $2.99	8
$3.00 to $3.24	48
$3.25 to $3.49	2
Miners' helpers—	
$0.75 to $0.99	1
$1.00 to $1.24	50
$1.25 to $1.49	62
$1.50 to $1.74	1
$1.75 to $1.99	52
$2.00 to $2.24	24
$2.25 to $2.49	22
$2.50 to $2.74	11
$2.75 to $2.99	8
Timbermen and track layers—	
$1.50 to $1.74	6
$2.00 to $2.24	11
$3.00 to $3.24	7
Boys under 16 years—	
Less than $0.50	2
$0.50 to $0.74	5
$1.00 to $1.24	1
All other wage earners—	
$0.50 to $0.74	17
$0.75 to $0.99	9
$1.00 to $1.24	80
$1.25 to $1.49	48
$1.50 to $1.74	27
$1.75 to $1.99	18
$2.00 to $2.24	121
$2.25 to $2.49	28
$2.50 to $2.74	28
$3.00 to $3.24	2
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	1,336
February	1,326
March	1,324
April	1,335
May	1,322
June	1,300
July	1,289
August	1,291
September	1,319
October	1,325
November	1,351
December	1,336
Boys under 16 years—	
January	7
February	7
March	7
April	7
May	7
June	7
July	14
August	12
September	7
October	7
November	7
December	7
Contract work:	
Amount paid	$23,164
Number of employees	80
Miscellaneous expenses:	
Total	$39,767
Royalties and rent of mine and mining plant	$7,078
Rent of offices, taxes, insurance, interest, and other sundries	$32,689
Cost of supplies and materials	$322,267
Product:	
Total value	$1,550,090
Quicksilver—	
Quantity, flasks	34,291
Value	$1,467,848
Cinnabar—	
Quantity, short tons	11,727
Value	$82,242
Power owned:	
Total horsepower	1,808
Engines—	
Steam—	
Number	56
Horsepower	1,574
Gas or gasoline—	
Number	17
Horsepower	152
Water wheels—	
Number	3
Horsepower	22
Other power—	
Number	5
Horsepower	60
Electric motors—	
Number	3
Horsepower	15

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[1] Includes operators distributed as follows: California, 34 (36 mines); Texas, 3 (5 mines).

[2] Includes timbermen and track layers.

PLATINUM

PLATINUM.

By David T. Day, Ph. D.

Occurrence.—At the time of the Eleventh Census platinum was known to occur in the United States in the following localities: California—Butte, Del Norte, Humboldt, Mendocino, Plumas, Sierra, and Trinity counties; Idaho—Wood river country; New York—near Plattsburg; North Carolina—Burke and Rutherford counties; and Oregon—Coos, Curry, Josephine, and Lane counties. In addition to these localities in the United States, there was a platinum product greater than that from the United States which helped to supply the American market from the region of Granite creek, British Columbia, and the copper ores from the Sudbury district of Canada also brought in some platinum and palladium in the nickel-copper matte imported into the United States.

Associated with these platinum ores were occasionally found the allied metals—osmium, iridium, and palladium.

About 1898 the demand for platinum became more considerable and the search for it, and especially for the allied metal osmium, became vigorous. It resulted in much prospecting in the Eastern states, as well as in the West, and many assays of supposed platinum ores, made by Mr. A. W. Johnston,[1] showed that certain rocks in eastern Pennsylvania, eastern New York, and in many other localities contained traces of platinum.

The one event of importance in the development of the platinum industry in the United States was the discovery by Dr. L. D. Godshall, manager of the Boston and Wyoming Smelter, at Encampment,[2] that the copper ores and matte of the Rambler mine, Grand Encampment district of Wyoming, contained platinum and palladium. These observations were confirmed by Professors Wells and Penfield, of Yale University,[3] who separated sperrylite (platinum diarsenide) from this Rambler ore. Further investigations by Mr. Johnston and Professor Kemp showed that the ore of the Rambler mine contains platinum intimately mixed with all the copper ores and even the chalcopyrite, which apparently was the original copper ore in this mine, also contains platinum. This confirms an observation of the writer in 1899 to the effect that platinum occurs in the pyrite grains found in certain hydraulic mines on the Trinity river in California, notably in the mine of Mr. F. Huertevant. These observations have led the searchers for platinum to examine a great many deposits of pyrite in the United States with the hope of finding them commercially rich in platinum, however, without commercial result, so far as the writer is informed. This work is referred to, however, as indicating a direction of search for platinum which may yet prove profitable.

At the time of the Twelfth Census, therefore, the supply of platinum to the United States market, in addition to the importations from Russia and small importations from South America, consisted in the supply of platinum obtained from the localities in California and Oregon mentioned above, a small product from the Granite creek district, British Columbia, and a more considerable product obtained in refining the nickel-copper matte from the Sudbury district of Canada. The platinum deposits of Russia, which afford the principal supply of the world, have lately been described by Mr. Chester V. Purington in the Engineering and Mining Journal, Vol. LXXVII, page 720. A complete description of the occurrence of platinum in all parts of the world is given by Prof. J. F. Kemp, of Columbia College, New York, in Bulletin 193, United States Geological Survey.

The writer made an investigation in 1899 as to the proportions of platinum, osmium, and iridosmium present with gold in various parts of the West, and, supplementary to this, Dr. Waldron Shapleigh determined the proportion of osmium to platinum in many of the same samples, the results of which are given in the following statement:[4]

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[1] James F. Kemp, United States Geological Survey, Bulletin 193, pages 31 and 33.

[2] Engineering and Mining Journal, Vol. LXII, page 843.

[3] American Journal of Science, fourth series, Vol. 13, 1902, page 95.

[4] Transactions of the American Institute of Mining Engineers, Vol. XXX, page 708.

		Highest per cent.	Lowest per cent.
Beegum district, Shasta county, Cal.	Platinum	20.0	13.5
	Other platinum metals[1]	84.0	79.0
Hayfork district, Trinity county, Cal.	Platinum	73.0	30.0
	Other platinum metals	58.0	18.0
Trinity river district, Trinity county, Cal.	Platinum	27.0	15.0
	Other platinum metals	80.0	72.0
Crescent City, Del Norte county, Cal.	Platinum	11.0	8.0
	Other platinum metals	83.0	46.0
Port Orford, Curry county, Oreg.	Platinum	47.0	15.0
	Other platinum metals	83.0	23.0

[1] The "other platinum metals" include iridium, osmium, ruthenium, rhodium, and palladium.

Production.—From the domestic ores in the United States the product during 1902 was 94 ounces, valued at $1,814. This was obtained as a side product in placer gold mining, and as the production is entirely dependent upon the more important production of gold this great decrease in the quantity of the platinum produced, as compared with 1,408 ounces in 1901, is easily understood. In fact, the product during the last few years has varied most widely both in quantity and in the value of the product. The variation in value has been due not only to the real fluctuation and gradual increase in the price of refined platinum, but particularly to the fact that the value given has been that of the crude grains as collected and which vary widely in their contents of pure platinum. In addition to the platinum product of 1902, 20 fine ounces of iridium were obtained. In 1901 the corresponding product was 253 ounces of iridium.

The production of platinum in previous years, as collected by the United States Geological Survey, is quoted in the following table:

TABLE 1.—*Production of crude platinum in the United States, 1880 to 1900, and of refined metal from domestic ores in 1901 and 1902.*[1]

YEAR.	Quantity (ounces).	Value.	YEAR.	Quantity (ounces).	Value.
1880	100	$400	1892	80	$550
1881	100	400	1893	75	517
1882	200	600	1894	100	600
1883	200	600	1895	150	900
1884	150	450	1896	163	944
1885	250	187	1897	150	900
1886	50	100	1898	225	3,375
1887	448	1,838	1899	300	1,800
1888	500	2,000	1900	400	2,500
1889	500	2,000	1901	1,408	27,526
1890	600	2,500	1902	94	1,874
1891	100	500			

[1] The chief variations in price have been due to the quality of the crude grains. In 1901 and 1902, however, the average price for the refined metal has been given.

Of the total production of platinum in the world, about 90 per cent comes from Russia, with the remainder divided among Colombia, South America; New South Wales, Australia; the United States; and Canada. The average annual product in Russia, as is shown in the following table, was 104,023.6 ounces for the ten years 1881 to 1890, inclusive, and 183,376 ounces for the eleven years 1891 to 1901, inclusive.

TABLE 2.—*Production of platinum in Russia: 1824 to 1901.*

YEAR.	PRODUCTION.		
	Ounces.	Russian equivalent.	
		Poods.[1]	*Funts.*
1824	[2] 1,066	2	1
1825	[2] 6,116	11	21.5
1826 to 1830	[2] 168,345	319	26.25
1831 to 1835	[2] 290,103	550	34
1836 to 1840	[2] 238,142	452	7.5
1841 to 1845	[2] 311,079	590	27.25
1846 to 1850	[2] 12,347	23	17.75
1851 to 1855	[2] 48,063	91	12
1856 to 1860	[2] 72,658	138	33
1861 to 1865	[2] 222,187	411	18
1866 to 1870	[2] 315,968	599	34.25
1871 to 1875	[2] 279,865	531	23.25
1876 to 1880	[2] 340,265	646	1
1881 to 1885	[2] 496,182	942	6.25
1886 to 1890	[2] 544,054	1,033	2
1891	[3] 135,873	258	....
1892	[3] 147,459	280	....
1893	[3] 159,099	302	....
1894	[3] 163,258	310	....
1895	[3] 141,110	268	....
1896	[3] 156,412	297	....
1897	[3] 174,311	331	....
1898	[3] 192,750	366	....
1899	[3] 191,697	364	....
1900	[3] 163,258	310	....
1901	[3] 203,283	386	....

[1] The pood is estimated at 526.64 ounces.

[2] Taken from the Russian Journal of Financial Statistics, 1901.

[3] Taken from the Viestnik Finansov (Messenger of Finance), No. 50, 1903.

Prices.—Since the close of 1899 the price of platinum has steadily increased, reaching its maximum value in January, 1902, when the price in New York was $20 to $21 per ounce for ingot platinum. The price fell to $19.50 in February, and in June to $19, which price prevailed to the close of the year. Best hammered platinum was quoted as follows: January, 1902, 82 cents per gram; June, 76 cents; July, 74 cents; August, 73.5 cents; and December, 72.5 cents. Osmiridium is quoted at from $6 to $10 per ounce. This gradual increase in the price of platinum during the past ten years is due to the fact that there has been found no metal or alloy which will take the place of platinum, and also to the fact that there is such a limited supply and increased demand.

The price of platinum is practically determined by Johnson, Matthey & Co., of London, who are refiners of a large portion of the Russian output.

Imports.—The following table gives the imports of platinum into the United States from 1880 to 1902, as reported by the Bureau of Statistics:

TABLE 3.—*Platinum imported and entered for consumption in the United States: 1880 to 1902.*

CALENDAR YEARS, SINCE 1886; PREVIOUS YEARS END JUNE 30.	Manufactured (value).	UNMANUFACTURED.		Vases or retorts, etc. (value).
		Quantity.	Value.	
		Pounds.		
1880	$964	....	$217,144	$41,827
1881	[illegible]	....	273,343	21,292
1882	1,731	3,128	285,731	48,452
1883	4	3,104	298,799	92,967
1884	....	2,846	289,898	83,112
1885	3	2,612	285,239	17,173
1886	....	3,422	373,941	71,864
1887		4,732	509,414	68,051
1888	....	5,226	558,930	58,355
1889	338	5,394	556,742	110,757
1890	....	5,763	996,886	77,967
1891	....	3,416	621,776	46,814
1892	....	5,419	565,476	60,210
1893	....	4,275	534,235	56,592
1894		4,099	485,272	88,195
1895	171	5,117	690,584	27,354
1896	....	5,558	906,671	106,286
1897	121	5,698	958,368	47,897
1898	271	6,703	1,179,242	62,012
1899	876	6,674	1,482,157	54,877
1900	827	7,372	1,725,206	85,887
1901	2,513	6,220	1,671,413	21,969
1902	2,706	7,346	1,950,382	34,913

COAL

COAL.

By Edward W. Parker.

The census of mines and quarries taken under the act providing for the Twelfth Census—the first of the twentieth century—found the United States firmly established as the principal coal producer of the world. At the taking of the Tenth and Eleventh censuses the United States was second in coal producing importance, with Great Britain first. At the Ninth Census it was exceeded in production by both Great Britain and Germany.

During the calendar year 1902, which is the period covered by the Twelfth Census of the mining industry, there were 27 states and 3 territories which contributed to the coal production of the United States. Of this number there were 5 in each of which the production amounted to less than 100,000 tons; there were 4 others in which the production was less than 1,000,000 tons; 5 states produced more than 10,000,000 tons each, and 1, Pennsylvania, produced more than 100,000,000 tons.

According to the character of the output, the coal fields of the United States conveniently fell under two great divisions, the anthracite and the bituminous. The areas from which the bulk of the anthracite is obtained are located in the eastern part of Pennsylvania, and ordinarily when reference is made to the anthracite fields of the United States those of eastern Pennsylvania are meant. There are, however, two small areas in the Rocky mountain region where true anthracite is produced in small quantities. One of these areas is in Gunnison county, Colo., the other in Santa Fe county, N. Mex. But, although the product of these two localities is true anthracite, the quantity obtained is so small that it is customary to include it with the bituminous production, and it is so included in this report.

The bituminous coal production shown here includes, in addition to the true bituminous coals, coking or noncoking, such varieties as semianthracite, semibituminous, cannel, splint, and block coals, and lignite or brown coal.

The following table is a comparative summary of the statistics of coal production as reported for the several census years from 1850 to 1902, inclusive:

Table 1.—COMPARATIVE SUMMARY: 1850 TO 1902.

	1902	1889	1880	1870	1860	1850
Number of mines	5,980	[1]12,552	[2]3,204	[2]1,566	[2]622	[2]510
Number of operators	4,528	(3)	(3)	(3)	(3)	(3)
Salaried officials, clerks, etc.:						
Number	17,427	[4]2,866	1,493	(5)	(5)	(5)
Salaries	$17,419,217	$2,193,870	(6)	(5)	(5)	(5)
Wage-earners:						
Average number	350,329	[4]296,623	169,141	94,754	36,486	15,118
Wages	$220,199,401	$106,937,058	[6]$55,276,055	$44,316,191	$9,650,264	$4,069,188
Contract work	$1,650,585	$3,155,171	(3)	(3)	(3)	(3)
Miscellaneous expenses	$26,061,698	$15,421,591	(3)	(3)	(3)	(3)
Cost of supplies and materials	$37,589,702	$18,828,500	$11,582,001	$5,668,955	$2,752,972	$246,411
Product:						
Quantity, short tons	301,590,439	141,229,513	71,481,570	36,807,393	14,333,922	6,445,681
Value	$367,032,069	$160,226,323	$95,740,396	$73,524,972	$20,243,637	$7,173,750

[1] Includes 9,969 "local" mines (9,920 bituminous and 49 anthracite) for which there are no statistics for labor and expenditures, production of same, 2,889,286 short tons.

[2] Establishments.

[3] Not reported.

[4] Foremen included as wage earners.

[5] Not reported separately.

[6] Salaries included in wages.

The following table shows the comparative statistics for the anthracite and bituminous coal industries, separately and combined, for 1889 and 1902:

TABLE 2.—COMPARATIVE SUMMARY: 1902 AND 1889.

	TOTAL.		BITUMINOUS.		ANTHRACITE.	
	1902	1889	1902	1889	1902	1889
Number of mines	5,986	[1]12,552	5,652	12,138	334	414
Number of operators	4,528	(²)	4,409	(²)	119	(²)
Salaried officials, clerks, etc.:						
Number	17,427	[3]2,936	14,413	2,408	3,014	528
Salaries	$17,419,217	$2,193,870	$14,511,924	$1,781,826	$2,907,293	$412,044
Wage-earners:						
Average number	350,329	[3]296,623	280,638	172,841	69,691	123,782
Wages	$220,198,401	$106,937,058	$181,482,288	$67,981,885	$38,716,113	$38,955,173
Contract work	$1,650,535	$3,155,171	$1,244,114	$822,051	$406,421	$2,333,120
Miscellaneous expenses	$26,081,698	$15,421,591	$16,774,459	$6,742,221	$9,307,239	$8,679,370
Cost of supplies and materials	$37,539,702	$18,828,590	$24,798,922	$7,994,219	$12,740,780	$10,834,371
Product:						
Quantity, short tons	301,590,439	141,229,513	260,216,844	95,629,026	41,373,595	45,600,487
Value	$367,032,069	$160,226,323	$290,858,483	$94,346,809	$76,173,586	$65,879,514

[1] Includes 9,969 "local" mines (9,920 bituminous and 49 anthracite) for which there are no statistics for labor and expenditures; production of same, 2,880,296 short tons.

[2] Not reported.

[3] Foremen included as wage-earners.

Two pronounced discrepancies appear in the foregoing tables. The first of these is the marked decrease in the number of mines reported for 1902, as compared with 1889. This decrease is due to the elimination, at the Twelfth Census, of a large number of small banks producing an insignificant amount of coal for purely local consumption, which were included in the previous census. At the taking of the Eleventh Census it was possible to make use of the enumerators to secure reports from these unimportant producers, but as the mining investigation at the Twelfth Census was not taken for the same year as that of population and manufactures, it was not possible to secure the services of enumerators to get the returns from these widely distributed and unimportant sources. Neither was it possible to obtain anything like complete reports by correspondence, and to have employed special agents for a complete canvass would have entailed an expense entirely out of proportion to the value of the results to be accomplished. The output from these small banks amounts to less than 1 per cent of the total, and to have made a complete canvass would have increased the cost of the investigation by probably 100 per cent. It would also have required a much longer time than could be allowed in order to complete the report within the time prescribed by law.

The second discrepancy requiring explanation is that existing between the number of wage-earners reported for 1902 and 1889. The difference is particularly noticeable in the statistics of anthracite production, where the number of wage-earners in 1902 appears to have been only 56.3 per cent of the number employed in 1889. In the bituminous mines, which increased 172.1 per cent in production, the number of wage-earners appears to have increased only 62.4 per cent. This makes it appear that in 1902 there were 861 tons of coal produced for each wage-earner employed, as compared with 476 tons in 1889. The reason for this is in part that, following the custom employed in the other reports for the Twelfth Census, the working time was assumed to have been three hundred days in the year, and the number of wage-earners had been equated in accordance with this assumption. In 1889 the average number was calculated for the actual time the mines were in operation and not for the whole year. The report of the United States Geological Survey, which has not been equated after the manner of the Twelfth Census, shows the average number of employees to have been 148,141 in the anthracite mines and 370,056 in the bituminous mines. The average time worked was one hundred and sixteen days in the anthracite mines and two hundred and thirty days in the bituminous mines. The total number of men employed, according to the report of the Survey, was 518,197, and the general average time worked was one hundred and ninety-seven days.

It is to be noted that the statistics for 1902 show a marked increase over 1889, both in the number of salaried officials and in the amount paid in salaries. This is explained by the fact that in 1889 only the salaried force employed at or in the immediate vicinity of the mines was included. On the other hand, officials and salaried employees in central offices or at a distance from the mines were included at the Twelfth Census. In 1889 the office forces at the mines numbered 2,936 persons, who were paid $2,193,870 in salaries. The salaried list at the census of 1902 included 17,427 persons who received $17,419,217. Comparable statistics for the two censuses include those for wages, for contract work, for miscellaneous expenses, and for supplies and materials. In 1889 these items aggregated $144,342,410, and in 1902, $285,470,336, making an increase for the period included between those dates of $141,127,926, or 97.8 per cent. During the same period, however, there was an increase of 129.1 per cent in the value of the product and of 113.5 per cent in the tonnage, due to the unusual conditions of the market in 1902. The foregoing statistics of expense do not include expenditures connected with the marketing of the product.

The following table shows the details of the capitalization of the incorporated companies operating coal mines, anthracite and bituminous:

TABLE 3.—*Capitalization of incorporated companies: 1902.*

	Total.	Anthracite	Bituminous.
Number of incorporated companies	1,593	76	1,517
Number reporting capitalization	1,519	69	1,450
Capital stock and bonds issued	$797,750,237	$142,032,212	$655,718,025
Capital stock:			
Total authorized—			
Number of shares	30,883,929	1,076,946	29,806,983
Par value	$653,855,920	$59,749,350	$594,106,570
Total issued—			
Number of shares	20,290,475	981,461	19,309,014
Par value	$568,906,676	$55,482,490	$513,424,186
Dividends paid	$19,296,300	$1,936,459	$17,359,841
Common—			
Authorized—			
Number of shares	29,480,914	1,065,346	28,415,568
Par value	$577,345,713	$58,589,350	$518,756,363
Issued—			
Number of shares	19,011,108	973,560	18,037,548
Par value	$498,441,649	$54,692,390	$443,749,259
Dividends paid	$15,230,787	$1,933,251	$13,297,536
Preferred—			
Authorized—			
Number of shares	1,403,015	11,600	1,391,415
Par value	$76,510,207	$1,160,000	$75,350,207
Issued—			
Number of shares	1,279,367	7,901	1,271,466
Par value	$70,465,027	$790,100	$69,674,927
Dividends paid	$4,065,513	$3,208	$4,062,305
Bonds:			
Authorized—			
Number	276,036	71,879	204,157
Par value	$241,418,778	$87,925,222	$153,493,556
Issued—			
Number	259,484	70,454	189,030
Par value	$228,843,561	$86,549,722	$142,293,839
Interest paid	$9,901,973	$3,786,145	$6,115,828
Assessments levied	$4,100,380	$1,797,319	$2,303,061

The total number of shares of common and preferred stock issued by all coal mining companies was 20,290,475, having a par value of $568,906,676, on which dividends were paid to the amount of $19,296,300, or 3.39 per cent. Deducting assessments levied the net dividends paid amounted to $15,195,920, or 2.67 per cent on the capital stock issued. The total par value of the stock of the anthracite companies was $55,482,490, on which dividends amounting to $1,936,459, or 3.49 per cent, were paid. The par value of the total stock issue of the bituminous coal companies was $513,424,186, on which dividends were paid to the amount of $17,359,841, or 3.38 per cent.

Employees and wages.—The average number of wage-earners employed during each month is shown in Table 4, for the coal industry as a whole as well as for the anthracite and bituminous mines separately.

TABLE 4.—*Average number of wage-earners employed during each month: 1902.*

	Total.	Anthracite.	Bituminous.
Total average number	350,329	69,691	280,638
Men 16 years and over:			
January	394,841	110,018	284,823
February	392,140	110,760	281,380
March	386,821	109,165	277,656
April	376,499	109,190	267,309
May	315,527	53,169	262,358
June	274,104	16,301	257,803
July	261,974	6,493	255,481
August	271,303	7,610	263,693
September	281,267	8,136	273,131
October	321,084	34,773	286,311
November	398,407	105,516	292,891
December	407,677	110,393	297,284
Boys under 16 years:			
January	14,076	8,362	5,714
February	14,095	8,468	5,627
March	14,090	8,419	5,671
April	14,135	8,517	5,618
May	8,634	2,986	5,648
June	5,502	52	5,450
July	5,395	59	5,336
August	5,576	96	5,480
September	5,666	100	5,566
October	7,439	1,696	5,743
November	13,631	7,804	5,827
December	14,065	8,209	5,856

The effect of the anthracite coal strike on the employment of labor in that industry is clearly shown in the above table.

For more than five months, or from May 12 to October 25, mining operations were almost entirely suspended in the anthracite region, the idleness being due to a strike among the mine workers. On account of the practically complete cutting off of the supply of anthracite, there existed, during the latter half of the year, a scarcity of fuel which amounted in many parts of the Eastern states to an actual famine. The strike was finally settled by the friendly and personal intervention of the President of the United States, who with the consent of the operators and the leaders of the striking miners appointed a commission "to inquire into, consider, and pass upon the questions in connection with the strike in the anthracite region, and the causes from which the controversy arose." Operations were resumed immediately upon the appointment of the commission, but owing to the necessity for repairs and for pumping water from many of the mines, occasioned by the long period of idleness, it was several weeks before normal conditions were restored.[1]

The average number of all wage-earners employed during July, 6,493—which was the minimum—closely approximates the average number of engineers, firemen, and other mechanics for the year, which was 6,513. The bituminous industry also shows that the minimum number was employed in July; the range, however, was not great, the minimum being less than 9 per cent below the average for the year.

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[1] This matter is thus briefly referred to here, partly because of its historic interest, but chiefly because the conditions are reflected in the statistics presented in this report and require some explanation. The report of the commission has been published and can be had upon application to the United States Commissioner of Labor. It contains some interesting statistical tables on the subject of wages paid to the different classes of labor, on the cost of living in the anthracite region, and other details which will be found useful to anyone interested in the study of the anthracite industry.

Of all employees engaged in the coal industry, 19.9 per cent were employed in anthracite mines, and 80.1 per cent in bituminous mines, while employees in the anthracite industry received only 17.5 per cent of the total amount paid in salaries and wages, leaving 82.5 per cent for those engaged in the bituminous industry.

The percentages of wage-earners employed above and below ground and the percentages for the several classes of wage-earners in the two branches of the coal industry are shown in the following statement:

Percentages of wage-earners above and below ground and by occupations: 1902.

	Anthracite.	Bituminous.
Wage-earners	100.0	100.0
Above ground	40.1	12.9
Below ground	59.9	87.1
Above ground	100.0	100.0
Engineers, firemen, and other mechanics	23.3	37.5
Boys under 16 years	13.7	2.3
All other wage-earners	63.0	60.2
Below ground	100.0	100.0
Miners	42.6	77.5
Miners' helpers	16.6	1.5
Boys under 16 years	1.8	1.9
All other wage-earners	39.0	19.1

Production.—During the calendar year 1902 the coal production of the United States amounted to 301,590,439 short tons, valued at the mines at $367,032,069. Of this total, 41,373,595 tons, valued at $76,173,586, were Pennsylvania anthracite, and 260,216,844 tons, valued at $290,858,483, were bituminous and lignite coal. Compared with the output reported at the Eleventh Census, the total production of coal in the United States in 1902 showed an increase of 160,360,926 short tons, or 113.5 per cent. This increase was all in the production of bituminous coal and lignite, for, on account of labor troubles in the anthracite fields of Pennsylvania, the output of anthracite in 1902 was restricted to about two-thirds of the normal production, and was less than that of 1889 by 4,226,892 short tons, or 9.3 per cent.

The production of bituminous coal in 1902 was abnormally stimulated by the scarcity of anthracite. Owing to the continuous activity and expansion in nearly all lines of manufactures, an increased production of bituminous coal would naturally have resulted, but would probably not have reached the amount it did had it not been for the fuel famine, especially in the Eastern states. On the other hand, conditions would have been greatly improved and the production and supply of bituminous coal would have been considerably increased had the transportation companies been able to meet the demands put upon them. The productive capacity of the bituminous mines could easily have supplied all the fuel needed had it been possible to get the product promptly to the consumer.

The production of bituminous coal in 1902 amounted to 260,216,844 short tons, valued at the mines at $290,858,483. As compared with 1889, when the production was 95,629,026 short tons, valued at $94,346,809, these figures show an increase of 164,587,818 short tons, or 172.1 per cent in amount, and of $196,511,674, or 208.3 per cent in value. The relatively higher value of the product in 1902 was due partly to the improved industrial conditions in that year, and partly to the increase in prices naturally resulting from the curtailment in anthracite production. The average price per short ton for bituminous coal in 1902 was $1.12, as compared with 99 cents in 1889.

The following table is a summary of production of anthracite and bituminous coal as reported at the last six censuses:

TABLE 5.—PRODUCTION OF ANTHRACITE AND BITUMINOUS COAL: 1850 TO 1902.

[Short tons.]

	1902	1889	1880	1870	1860	1850
Total	301,590,439	141,229,513	71,481,570	36,807,333	14,333,922	6,445,681
Anthracite	[1] 41,467,532	[2] 45,600,487	28,649,812	17,543,988	8,115,842	4,138,164
Per cent of total	13.7	32.3	40.1	47.7	56.6	64.2
Bituminous	260,122,907	95,629,026	42,831,758	19,263,345	6,218,080	2,307,517
Per cent of total	86.3	67.7	59.9	52.3	43.4	35.8

[1] Includes 93,937 tons of anthracite produced in Colorado and New Mexico.

[2] Includes 53,517 tons of anthracite produced in Colorado and New Mexico, and 2,000 tons of graphitic coal produced in Rhode Island.

It will be observed in the foregoing table that in 1850 the anthracite product of Pennsylvania was nearly two-thirds of the coal production of the country, and that in 1870 the production of coal in the United States was nearly equally divided between the anthracite product of Pennsylvania and the output of bituminous mines; whereas in 1902 the production of bituminous coal was 6¼ times that of anthracite. Had it not been for the strike, however, the production of the anthracite fields in 1902 would probably have reached a total of about 65,000,000 tons, indicating that under normal conditions the output of bituminous coal in 1902 would have been about four times that of anthracite.

One of the interesting features connected with the coal mining industry during the last quarter of a century has been the gradual elimination of anthracite as a factor in manufacturing. Bituminous coal has largely supplanted anthracite for manufacturing purposes, even in the Eastern states, while the latter has become more and more restricted to household consumption. For this reason the normal increase in the production of anthracite coal has been about in proportion to the increase in population, whereas the increase in bituminous production has rapidly outstripped the increase in population, as it has the increase in production of anthracite coal.

The development of the coal resources of the United States has been coincident with the rapid advancement of this country in the last few years to the front rank among the industrial nations of the world. Indeed, the country's progress has been due largely to the abundance and cheapness of its mineral fuels, chief among which is coal. Most of this development has taken place during the last two decades and has far exceeded the growth in population, indicating a rapid change from an agricultural to a manufacturing nation. A comparison of the growth in population with the increase in production presents some interesting facts in support of this statement. The Ninth Census was the first which took separate cognizance of the mining industry, but the United States Geological Survey has compiled from such records as are available an approximate statement of the annual coal production of the United States from the year when the first anthracite coal was mined in Pennsylvania (1814) to the close of 1902.

Diagram 1 illustrates the growth of the coal production of the country from 1830 to 1902, both in production per capita and in comparison with the increase in population.

The following table gives the population and coal production, respectively, from 1830 to 1902, with the per cent of increase during each intervening period and the average amount of coal product per unit of population. The statistics, except those for 1890 and 1902, are taken from the reports of the United States Geological Survey.

TABLE 6.—*Population and coal production: 1830 to 1902.*

CENSUS OF—	Population	Per cent of increase.	Coal production (short tons).	Per cent of increase.	Tons of coal per unit of population.
1830	12,866,020	....	318,072	....	0.025
1840	17,069,453	32.7	1,785,574	461.4	0.106
1850	23,191,876	35.9	6,445,681	261.0	0.278
1860	31,443,321	35.6	16,169,736	150.9	0.514
1870	38,558,371	22.6	36,806,560	127.6	0.955
1880	50,189,209	30.1	76,157,944	106.9	1.518
1890	63,069,756	24.9	[1] 141,229,613	85.4	2.239
1900	76,303,387	21.0	269,684,027	91.0	3.534
1902	[2] 78,576,436	3.0	301,590,439	11.8	3.838

[1] For calendar year 1889.

[2] Estimates of population, United States Census, Bulletin No. 7, 1904.

At the taking of the census of 1820 the production of coal in this country was less than 500 tons, all of which was Pennsylvania anthracite. The population of the United States in that year was 9,638,453. In 1830, when the population had grown to 12,866,020, the production of coal amounted to 318,072 short tons. At the end of the next decade the population of the United States was 17,069,453, and the coal output was 1,785,574 short tons. The production per capita in that year (1840) was 0.105 ton. This was the first census year in which the coal production amounted to as much as 0.1 ton for each person. In 1850, when the inhabitants numbered 23,191,876, the output of coal mines amounted to only 6,445,681 short tons, or 0.28 ton for each person. The census of 1860 gave a population of 31,443,321, and the coal production was 16,169,736 short tons, or 0.51 ton per capita. When the Ninth Census was taken the coal production was still less than 1 ton for each inhabitant, the population being 38,558,371, and the coal production amounting to 36,806,560, or 0.96 ton per capita.

In 1880, when the population had increased to 50,189,209, the production of coal had grown to 76,157,944 short tons, or 1.52 tons per capita. The mining census for the calendar year 1889 showed a coal production of 141,229,613 short tons and the population census for the fiscal year ending June 30, 1890, showed a total of 63,069,756 persons, the per capita production of coal being 2.26 tons. The Twelfth Census reported a population of 76,303,387, the United States Geological Survey reporting for that year a coal production of 269,684,027 short tons, or 3.53 tons for each inhabitant. If the population for 1902 be estimated at 78,576,436, the per capita coal production is shown to have been 3.84 tons for that year.

It must be remembered that within the last thirty years, during which the coal production has so markedly outstripped the growth in population, petroleum and natural gas have been produced in enormous quantities and to the value of many millions of dollars annually. The increased output of these fuels, however, has been partly offset by a decrease in the amount of wood used for fuel, but while it is known that such a decrease has taken place, there are no statistics by which comparisons can be made.

The following comparative statement shows the average production per mine and per employee from the statistics given in Table 1:

Average production per mine and per employee for each census year: 1850 to 1902.

	1902	1889	1880	1870	1860	1850
Average product:						
Per mine, tons	50,383	[1] 58,578	21,701	20,986	23,045	12,539
Per employee, tons	505	476	422	347	393	436

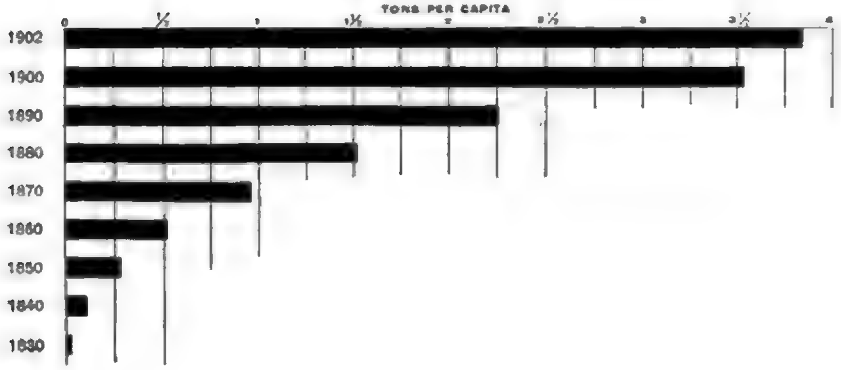
[1] Exclusive of local mines.

In all the later decades there was a steady increase in the output per employee.

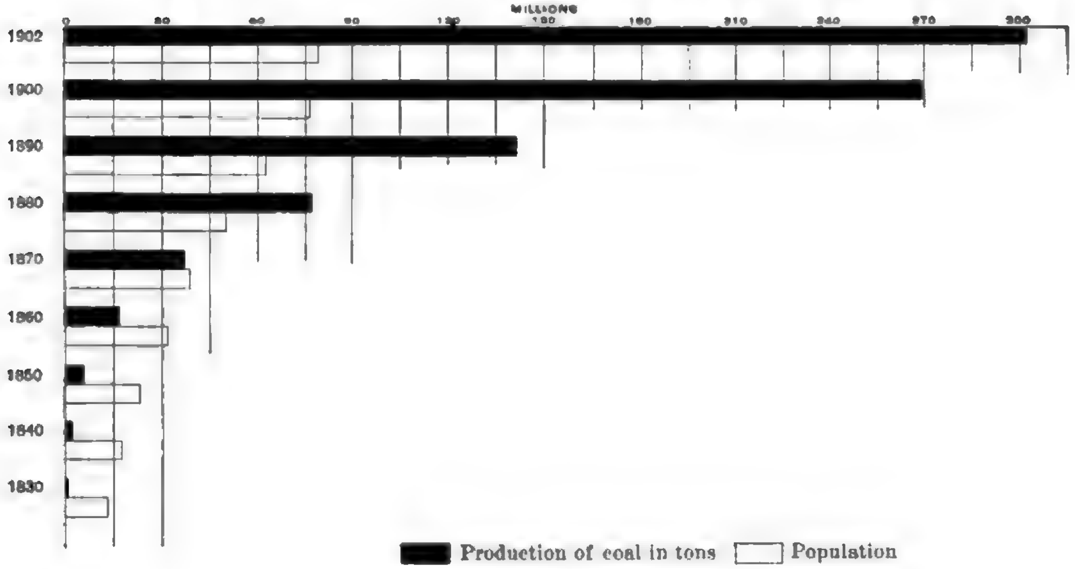
Annual statistics compiled by the United States Geological Survey show that the United States has exceeded Germany's production in every year since and including 1871, with the exception of the two years 1875 and 1876, and since and including 1899 has outranked

DIAGRAM I.—(*a*) PRODUCTION OF COAL PER CAPITA; (*b*) COMPARISON OF POPULATION WITH PRODUCTION: 1830 TO 1902.

(*a*) Production of coal per capita: 1830 to 1902.



(*b*) Comparison of population with production of coal: 1830 to 1902.



Great Britain. In 1901 and 1902 the United States exceeded in coal production the combined output of Great Britain and all its colonies and dependencies.

The following table shows the production of coal in the United States, Great Britain, Germany, and the other countries of the world in each census year from 1870 to 1902, and the same is shown graphically by Diagram II. The imports and exports of coal for the United States and the domestic production and consumption are also indicated by Diagram II.

TABLE 7.—WORLD'S PRODUCTION OF COAL, BY COUNTRIES, WITH PER CENT EACH IS OF TOTAL, AND PER CENT OF INCREASE: 1870 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Short tons.]

COUNTRY.	1902	1889	1880	1870	INCREASE, 1870 TO 1902	
					Quantity.	Per cent.
All countries	884,803,434	531,797,039	369,413,780	238,621,068	646,182,366	270.8
United States	301,590,439	141,229,513	76,157,944	36,806,560	264,783,879	719.4
Per cent of total	34.1	26.6	20.6	15.4	41.0	....
Great Britain	254,346,447	198,146,731	164,605,738	123,682,935	130,663,512	105.6
Per cent of total	28.8	37.2	44.6	51.8	20.2	....
Germany	165,826,496	93,640,500	65,177,634	37,488,312	128,338,184	342.8
Per cent of total	18.7	17.6	17.6	15.7	19.9	....
All other countries[1]	163,040,052	98,780,195	63,472,464	40,643,261	122,396,791	301.1
Per cent of total	18.4	18.6	17.2	17.1	18.9	....

[1] Includes Austria-Hungary (1901), 45,417,959; France, 33,296,146; Belgium (1901), 24,485,842; Russia (1901), 17,984,201; India, 8,326,049; Japan (1900), 8,187,282; Canada, 7,639,225; New South Wales, 6,655,052; Spain (1901), 3,027,992; New Zealand (1901), 1,374,956; Mexico, 782,251; South African Republic (1901), 752,116; Natal, 663,960; Queensland (1901), 604,209; Italy (1901), 469,154; Holland (1900), 352,888; Sweden, 335,907; Victoria (1901), 234,448; Cape Colony (1900), 222,265; Tasmania (1900), 48,171; China, Turkey, Servia, Portugal, United States of Colombia, Chile, Borneo and Labuan, Peru, Greece, etc., 2,240,000.

This table shows that while in a period of approximately thirty years the coal production of Great Britain had only a little more than doubled, that of the United States in 1902 was more than eight times what it was in 1870. It also shows that Germany and all other countries combined have only approximately quadrupled their production of coal in the same period.

ANTHRACITE.

The anthracite coal product herein reported is confined to the state of Pennsylvania, the small output of Colorado and New Mexico being included in the statistics for bituminous coal. The following table is a summary of the statistics for anthracite production in Pennsylvania, by counties, during 1902:

TABLE 8.—SUMMARY, PENNSYLVANIA ANTHRACITE, BY COUNTIES: 1902.

	Total.	Carbon.	Columbia.	Lackawanna.	Luzerne.	Northumberland.	Schuylkill.	Other counties.[1]
Number of mines	334	11	4	91	113	24	85	6
Number of operators	119	[illegible]	2	23	36	12	35	5
Salaried officials, clerks, etc.:								
Number	3,014	87	67	483	843	350	1,098	86
Salaries	$2,907,293	$82,814	$63,518	$461,964	$839,060	$294,519	$1,108,728	$56,670
Wage-earners:								
Average number	69,691	2,114	1,275	16,175	26,001	6,691	16,385	2,050
Wages	$38,716,113	$1,111,578	$711,272	$9,535,166	$13,939,752	$3,551,366	$8,609,384	$1,257,596
Contract work	$406,421	$50,697	$17,408	$56,614	$151,970	$16,483	$111,249	....
Miscellaneous expenses	$9,307,239	$193,513	$247,125	$1,955,982	$3,776,263	$690,083	$2,301,154	$143,119
Cost of supplies and materials	$12,740,780	$370,268	$343,018	$2,441,760	$4,601,407	$1,172,483	$3,375,690	$236,154
Product:								
Quantity, long tons	36,940,710	986,201	670,116	10,779,268	12,852,826	2,878,615	7,704,202	1,069,483
Value	$76,173,586	$1,942,361	$1,375,099	$22,534,716	$27,622,900	$5,602,584	$15,061,292	$2,044,634

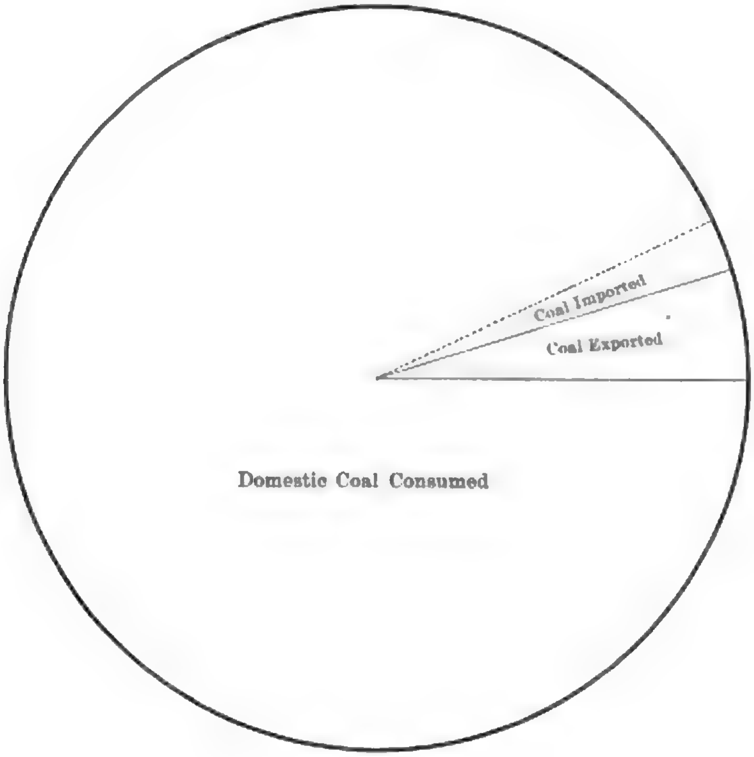
[1] Includes operators distributed as follows: Dauphin county, 2; Sullivan county, 2; Susquehanna county, 1 (2 mines).

There were 2 anthracite coal mines in Pennsylvania in the development stage for which no production was reported. One was in Luzerne county and the other in Schuylkill. These were operated by 2 of the active companies and the statistics therefor are included in the statistics for the developing bituminous coal mines of the state. There were 17 idle mines proper, distributed, by counties, as follows: Lackawanna, 1; Luzerne, 4; Northumberland, 4; and Schuylkill, 8.

Employees and wages.—In Table 9 the distribution of wage-earners according to daily rates is shown by occupations.

DIAGRAM II.—(*a*) DOMESTIC PRODUCTION AND CONSUMPTION OF COAL, 1902; (*b*) COAL PRODUCTION OF THE WORLD: 1902, 1890, 1880, AND 1870.

(*a*) Domestic production and consumption of coal: 1902.



(*b*) Coal production of the world: 1902, 1890, 1880, and 1870.

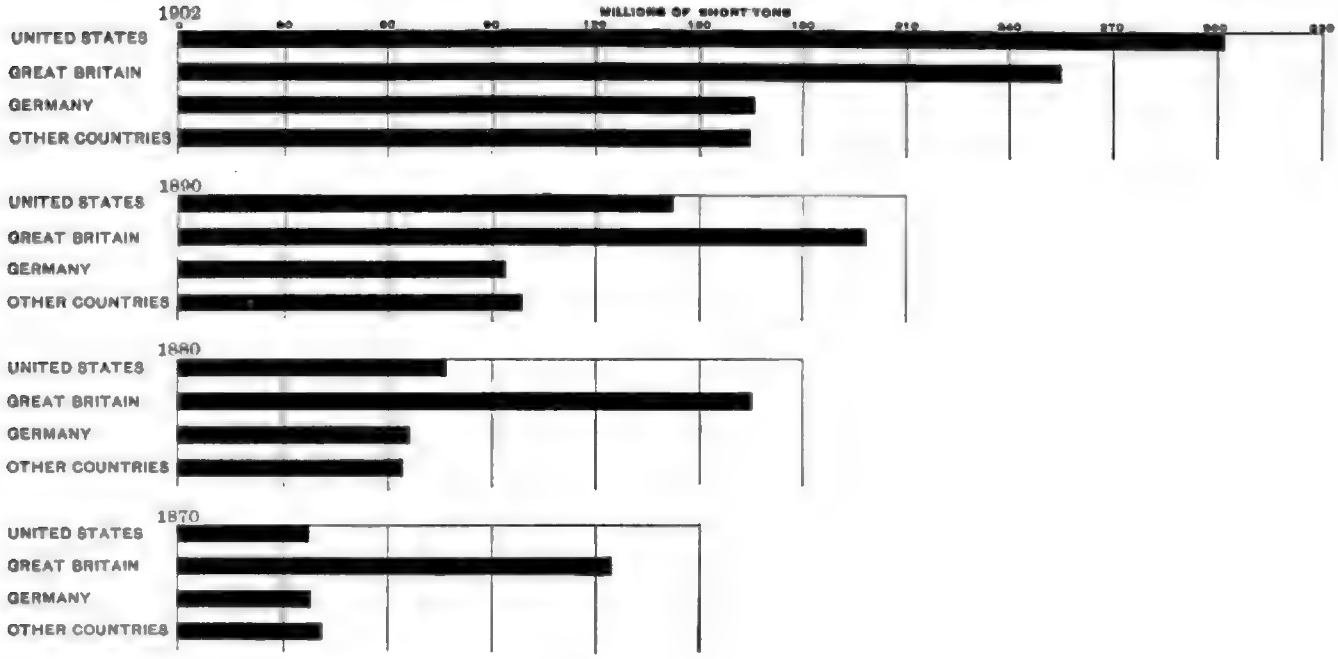


TABLE 9.—COAL, ANTHRACITE—WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.			ENGINEERS.			FIREMEN.			MACHINISTS, BLACKSMITHS, AND OTHER MECHANICS.		
	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.
Total	69,691	100.0		2,064	100.0		1,836	100.0		2,613	100.0	
Less than 0.50	70	0.1	100.0									
0.50 to 0.74	2,459	3.5	99.9									
0.75 to 0.99	3,808	5.5	96.4	3	0.1	100.0				1	(1)	100.0
1.00 to 1.24	6,546	9.4	90.9	49	2.4	99.9	9	0.5	100.0	20	0.8	[illegible]
1.25 to 1.49	8,495	12.2	81.5	68	3.3	97.5	123	6.7	99.5	67	2.6	99.2
1.50 to 1.74	10,712	15.4	69.3	273	13.2	94.2	621	33.8	92.8	371	14.2	96.6
1.75 to 1.99	11,547	16.6	53.9	455	22.1	81.0	815	44.4	59.0	428	16.4	82.4
2.00 to 2.24	8,159	11.7	37.3	509	24.7	58.9	219	11.9	14.6	823	31.5	66.0
2.25 to 2.49	7,253	10.4	25.6	247	12.0	34.2	21	1.1	2.7	673	25.7	34.5
2.50 to 2.74	3,132	4.5	15.2	369	17.9	22.2	27	1.5	1.6	156	6.0	8.8
2.75 to 2.99	1,819	2.6	10.7	75	3.6	4.3	1	0.1	0.1	47	1.8	2.8
3.00 to 3.24	1,806	2.6	8.1	13	0.6	0.7				20	0.8	1.0
3.25 to 3.49	1,382	2.0	5.5	3	0.1	0.1				2	0.1	0.2
3.50 to 3.74	1,317	1.9	3.5							4	0.1	0.1
3.75 to 3.99	517	0.7	1.6									(1)
4.00 to 4.24	167	0.2	0.9							1	(1)	(1)
4.25 and over	502	0.7	0.7									

RATE PER DAY (DOLLARS).	MINERS.			MINERS' HELPERS.			TIMBERMEN AND TRACK LAYERS.			BOYS UNDER 16 YEARS.			ALL OTHER WAGE-EARNERS.		
	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative per cent age.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.
Total	17,767	100.0		6,921	100.0		1,977	100.0		4,564	100.0		31,949	100.0	
Less than 0.50										69	1.5	100.0	1	(1)	100.0
0.50 to 0.74										2,006	44.0	98.5	453	1.4	[illegible]
0.75 to 0.99				2	(1)	100.0	2	0.1	100.0	1,881	41.2	54.5	1,919	6.0	98.6
1.00 to 1.24				441	6.4	99.9	50	2.5	99.9	580	12.7	13.3	5,397	17.0	92.6
1.25 to 1.49	26	0.2	100.0	947	13.7	93.6	61	3.1	97.4	26	0.6	0.6	7,177	22.5	75.6
1.50 to 1.74	271	1.5	99.8	921	13.3	79.9	304	15.4	94.3	2	(1)	(1)	7,949	24.8	53.1
1.75 to 1.99	1,101	6.2	98.3	2,086	30.1	66.6	624	31.6	78.9				6,038	18.9	28.3
2.00 to 2.24	3,288	18.5	92.1	1,196	17.3	36.5	326	16.5	47.3				1,793	5.6	9.4
2.25 to 2.49	3,776	21.3	73.6	1,211	17.5	19.2	579	29.3	30.8				746	2.3	3.8
2.50 to 2.74	2,195	12.4	52.3	117	1.7	1.7	23	1.2	1.5				245	0.8	1.5
2.75 to 2.99	1,542	8.7	39.9				5	0.2	0.3				149	0.5	0.7
3.00 to 3.24	1,692	9.5	31.2				2	0.1	0.1				79	0.2	0.2
3.25 to 3.49	1,378	7.7	21.7				1	(1)	(1)				3	(1)	(1)
3.50 to 3.74	1,313	7.4	14.0												
3.75 to 3.99	517	2.9	6.6												
4.00 to 4.24	166	0.9	3.7												
4.25 and over	502	2.8	2.8												

[1] Less than one-tenth of 1 per cent.

As shown by the above table, the great majority of the wage-earners received from $0.50 to $2.74 per day, 62,111, or 89.1 per cent of all wage-earners having been reported at rates between those limits. But two factors somewhat peculiar to the coal industry make such generalization misleading: (1) The large number of boys employed lessens the average wage as a whole; (2) the bulk of the mining is done on a tonnage or yardage basis, the equivalent daily rate of pay for the periods reported being calculated from the amount paid and the number of miners so employed.

There were 17,767 miners reported, 25.5 per cent of all wage-earners in the industry, and there were 6,921 miners' helpers. Of the miners 15,285, or 86 per cent, were paid from $1.75 to $3.74 per day, the largest number embraced within a single rate group 3,776, or 21.3 per cent of all miners, receiving from $2.25 to $2.49 per day. There were 1,185, or 6.7 per cent, who received pay at the rate of $3.75 or more per day. A larger number of miners' helpers were included in the rate group of $1.75 to $1.99 per day than in any other group, and 91.9 per cent of the miners' helpers, or 6,361 men, were paid from $1.25 to $2.49 per day. The range of wages for 1,853 engineers, 89.8 per cent of all reported, was from $1.50 to $2.74, and of the 1,836 firemen, 1,778, or 96.8 per cent, received between $1.25 and $2.24. Of 2,613 machinists, blacksmiths, and other mechanics, 2,451, or 93.8 per cent, were paid between $1.50 and $2.74. The largest number of timbermen and track layers in one rate group, 624, or 31.6 per cent of all in this class, was paid from $1.75 to $1.99 per day, and 1,833, or 92.7 per cent, were reported at rates between $1.50 and $2.49 per day. The 4,564 boys under 16 years of age, comprised 6.5 per cent of all wage-earners. Of this number 2,006, or 44 per cent, received from $0.50 to $0.74 per day, and 4,467, or 97.9 per cent of the total number, were reported at rates between $0.50 and $1.24 per day. The group of "all other wage-earners" comprised 45.8 per cent of the total number of wage-earners reported. Their wages ranged from less than $0.50 per day to $3.49 per day, but 83.1 per cent received from $1 to $1.99, while only 9.5 per cent received $2 per day or over and but 7.4 per cent less than $1 per day.

The following table shows the distribution of wage-earners according to daily rates of pay, by counties:

TABLE 10.—COAL, ANTHRACITE—WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, BY COUNTIES: 1902.

[Each cumulative percentage shows the proportion of total number of persons receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL COUNTIES.			CARBON.			LACKAWANNA.			LUZERNE.			NORTHUMBERLAND.			SCHUYLKILL.			ALL OTHER COUNTIES.[1]		
	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.	Number.	Per cent of total.	Cumulative percentage.
Total	69,691	100.0	....	2,114	100.0	....	16,175	100.0	....	25,001	100.0	....	6,691	100.0	....	16,385	100.0	....	3,325	100.0	....
Less than 0.50	70	0.1	100.0	5	0.2	100.0	1	(²)	100.0	36	0.1	100.0	1	(²)	100.0	10	0.1	100.0	17	0.5	100.0
0.50 to 0.74	2,459	3.5	99.9	111	5.3	99.8	421	2.6	99.9	1,054	4.2	99.9	230	3.4	99.9	550	3.4	99.9	93	2.8	99.5
0.75 to 0.99	3,808	5.5	96.4	148	7.0	94.5	598	3.7	97.4	1,550	6.2	95.7	354	5.3	96.6	1,049	6.4	96.5	109	3.3	96.7
1.00 to 1.24	6,546	9.4	90.9	174	8.2	87.5	2,542	15.7	93.7	1,946	7.8	89.5	428	6.4	91.3	1,228	7.5	90.1	228	6.9	93.4
1.25 to 1.49	8,495	12.2	81.5	308	14.6	79.3	2,307	14.3	78.0	3,382	13.5	81.7	809	12.1	84.9	1,475	9.0	82.6	214	6.4	86.5
1.50 to 1.74	10,712	15.4	69.3	358	16.9	64.7	2,833	17.5	63.7	3,219	12.9	68.2	1,393	20.8	72.8	2,331	14.2	73.6	578	17.4	80.1
1.75 to 1.99	11,547	16.6	53.9	344	16.3	47.8	1,546	9.6	46.2	3,864	15.4	55.3	1,203	18.0	52.0	4,081	24.9	59.4	509	15.3	62.7
2.00 to 2.24	8,159	11.7	37.3	155	7.3	31.5	1,028	6.4	36.6	2,674	10.7	39.9	1,147	17.2	34.0	2,258	13.8	34.5	897	27.0	47.4
2.25 to 2.49	7,253	10.4	25.6	145	6.9	24.2	969	6.0	30.2	2,972	11.9	29.2	610	9.1	16.8	2,334	14.2	20.7	223	6.7	20.4
2.50 to 2.74	3,132	4.5	15.2	130	6.1	17.3	636	3.9	24.2	1,628	6.5	17.3	117	1.8	7.7	503	3.1	6.5	118	3.5	13.7
2.75 to 2.99	1,819	2.6	10.7	179	8.5	11.2	472	2.9	20.3	541	2.2	10.8	370	5.5	5.9	253	1.5	3.4	4	0.1	10.2
3.00 to 3.24	1,806	2.6	8.1	42	2.0	2.7	507	3.1	17.4	867	3.5	8.6	29	0.4	0.4	232	1.4	1.9	129	3.9	10.1
3.25 to 3.49	1,382	2.0	5.5	....	....	0.7	1,007	6.2	14.3	365	1.5	5.1	....	....	....	9	0.1	0.5	1	(²)	6.2
3.50 to 3.74	1,317	1.9	3.5	....	....	0.7	829	5.1	8.1	360	1.4	3.6	....	....	....	71	0.4	0.4	57	1.7	6.2
3.75 to 3.99	517	0.7	1.6	15	0.7	0.7	109	0.7	3.0	392	1.6	2.2	....	....	....			(²)	1	(²)	4.5
4.00 to 4.24	167	0.2	0.9	....	....	....	160	1.0	2.3	1	(²)	0.6	....	....	....	1	(²)	(²)	5	0.2	4.5
4.25 and over	502	0.7	0.7	....	....	....	210	1.3	1.3	150	0.6	0.6							142	4.3	4.3

[1] Includes Columbia, Dauphin, Sullivan, and Susquehanna.

[2] Less than one-tenth of 1 per cent.

In the above table the statistics are separately reported for the counties of Carbon, Lackawanna, Luzerne, Northumberland, and Schuylkill. The amount paid for contract mining, which is included in wages paid, and the average number of employees doing such work, who are included in wage-earners, are shown in the following statement:

Coal, anthracite—contract mining, by counties: 1902.

	Total.	Carbon.	Lackawanna.	Luzerne.	Northumberland.	Schuylkill.	All other counties.
Amount paid	$16,572,781	$358,013	$4,756,929	$6,171,054	$1,526,865	$3,113,770	$646,011
Average number of employees	23,379	547	5,876	8,796	2,372	4,879	909

Of the total amount paid as wages to miners and miners' helpers, 92 per cent was on account of contract mining, hence the difficulty as before noted of deducing daily rates for the miners. In Carbon county the amount paid for contract mining constituted 99 per cent of wage payments to miners and miners' helpers; in Lackawanna county it constituted 96.1 per cent; in Luzerne county, 93.2 per cent; in Northumberland county, 91.6 per cent; and in Schuylkill county, 89.3 per cent.

Contract work.—Contract work does not include contract mining by the ton or otherwise, but only work done by contract in the way of tunneling, shaft sinking, etc. For this kind of work the sum of $406,421 was expended and 1,731 men were employed.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials reported as $12,740,780, is the largest item of expense other than wages and salaries. Of the $9,307,239 expended for miscellaneous expenses, $4,359,051 was paid for royalties and rent of mines and mining plant, and $4,948,188 was for rent of offices, taxes, and other sundries.

Mechanical power.—A total of 434,220 horsepower was reported as owned by the anthracite coal operators, of which 415,827 horsepower, or 95.8 per cent, was furnished by 4,629 steam engines, 185 horsepower by 6 gas or gasoline engines, and 18,208 horsepower by 234 primary motors of other kinds. In addition electric motors to the number of 78, aggregating 5,755 horsepower, were reported as owned by the operators.

Production.—The production of anthracite in Pennsylvania during 1902 amounted to 36,940,710 long tons, which was less than that of 1889 by 3,724,442 long tons. This decrease was due solely to the strike in the anthracite region. The normal production of the region, according to the statistics compiled by the United States Geological Survey, is between 50,000,000 and 55,000,000 long tons per year. The suspension of work for more than five months cut down the production to about 60 per cent of the normal output. It must not be considered, therefore, that the statistics of anthracite production presented here represent the normal condition of the industry.

The total production from the time coal was first mined in Pennsylvania in 1814 to the close of 1902 is estimated at a little over 1,500,000,000 short tons, or an average of nearly 18,000,000 tons a year. During the ten years from 1893 to 1902, inclusive, the average annual production has amounted to a little over 55,000,000 short tons.[1]

The anthracite areas of Pennsylvania are included in the 9 counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan. The total area of the anthracite fields of Pennsylvania is about 484 square miles.

The following statement shows the percentage of production for each county:

Percentage of anthracite production.

COUNTY.	Per cent.
Total	100.0
Luzerne	34.8
Lackawanna	29.2
Schuylkill	20.8
Northumberland	7.8
Carbon	2.7
Columbia	1.8
Susquehanna	1.1
Dauphin	1.0
Sullivan	0.8

The distribution of the product for consumption, for each county, during 1902, is shown in the following table:

TABLE 11.—*Anthracite production and distribution for consumption, by counties: 1902.*

[Long tons.]

COUNTY.	Total quantity.	Shipments.	Local trade.	Used at mines.
Total	36,940,710	31,486,120	995,655	4,458,935
Luzerne	12,852,826	11,040,374	377,379	1,435,073
Lackawanna	10,779,268	9,659,014	269,678	850,576
Schuylkill	7,704,202	6,240,258	193,278	1,270,666
Northumberland	2,878,615	2,308,253	92,719	477,643
Carbon	986,201	796,791	24,621	164,789
Columbia	670,115	588,058	11,323	70,734
Susquehanna	404,248	373,451	9,792	21,005
Dauphin	369,235	194,691	13,883	160,661
Sullivan	296,000	285,230	2,982	7,788

The shipments constitute 85.2 per cent of the total production, 2.7 per cent being sold in local trade, and 12.1 per cent consumed at the mines.

The classification of the Sullivan county product as anthracite has given rise to some contention. This coal lies in an isolated district known as the Bernice basin, in the northeastern part of Sullivan county and extending into the southeastern part of Wyoming county. Its physical characteristics are more like semianthracite than true anthracite, but on account of its high percentage of fixed carbon and low percentage of moisture it is classed as an anthracite by the Second Pennsylvania Geological Survey, and it is so considered in this report.

In a general way the anthracite coal field may be said to be bounded on the north by the north branch of the Susquehanna river, on the east by the Delaware and Lehigh rivers, and on the west by the Susquehanna river. These rivers, together with the Schuylkill, form the drainage outlets for the region. The entire anthracite region embraces a territory of about 3,300 square miles, but less than one-sixth of this total area, or about 484 square miles, is underlaid by workable deposits of coal. The productive portion is not in a continuous area, but consists of a number of detached valleys or basins, the general trend of which is about 60° N. to 70° E. They are arranged en échelon, from NE. to SW., for a distance of 120 miles. The greatest width is 30 miles, from Mauch Chunk to Shickshinny, or 50 miles if the Bernice basin in Sullivan county be considered as a portion of the anthracite field proper.

The anthracite coal fields, exclusive of the Bernice basin, are divided into 3 general trade regions, known as the Wyoming, Lehigh, and Schuylkill. Geographically these regions are subdivided into 4 well-defined fields or basins, known as the Northern, Eastern Middle, Southern, and Western Middle. These fields or basins are again subdivided, for convenience of identification, into districts as follows:

Anthracite coal fields, by field, local district, and trade region.

COAL FIELD OR BASIN.	Local district.	Trade region.
Northern	Carbondale Scranton Pittston Wilkesbarre Plymouth Kingston	Wyoming.
Eastern Middle	Green Mountain Black Creek Hazelton Beaver Meadow	Lehigh.
Southern	Panther Creek East Schuylkill West Schuylkill Lorberry Lykens Valley	Schuylkill.
Western Middle	East Mahanoy West Mahanoy Shamokin	

Of the 4 geographic divisions named above, the Southern is the largest, containing 181 square miles. The Northern is the next in size, containing 176 square miles. The Western Middle, the third in size, contains 94 square miles, and the Eastern Middle, the smallest of the divisions, contains 33 square miles.

The Northern basin.—The Northern basin extends from Forest City, on the northeast, to Shickshinny, on the southwest, a distance of 55 miles, and is drained by the valleys of the Lackawanna and the Susquehanna rivers. Its maximum width is about 6 miles. This basin, which is also known as the Wyoming Trade region, was the last of the anthracite basins to be developed. Mining was first begun here in 1829, the shipments in that year amounting to 7,000 long tons, or 6.25 per cent of the total anthracite shipments from the region. This region gradually developed in importance until it is now the most productive portion of the anthracite coal fields. Since 1883 more than 50 per cent of the shipments have been from the Northern basin, or Wyoming region, as it is differently called. In 1902 this region contributed 61.73 per cent of the entire shipments of anthracite. From 1829 to the close of 1902 this basin or region shipped 626,798,256 long tons of 2,240 pounds, or 49.87 per cent of the entire shipments from the anthracite coal fields of Pennsylvania.

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[1] In previous years some coal which was classed as anthracite was mined in the eastern part of Rhode Island, and in Bristol and Plymouth counties in Massachusetts. This product is, however, in reality of a graphitic quality and not anthracite. It is not now mined for fuel purposes, and the production is included with that of graphite.

The Eastern Middle field.—This is the smallest of the 4 main geographical divisions and lies about 15 miles south of the western end of the Northern basin, from which it is separated by a mountain range and a valley. Its greatest length is about twenty-six miles and its greatest width about ten miles, the total coal area containing about thirty-three miles.

The Eastern Middle basin forms what is known as the Lehigh Trade region, and enjoys the distinction of having the earliest recorded anthracite shipments. In 1820, 365 long tons of coal were shipped from the Lehigh region, and in the eighty-three years from 1820 to 1902, inclusive, it has shipped a total of 212,039,554 long tons, or 16.87 per cent of the total anthracite shipments.

The Southern basin.—This is the largest of the anthracite coal fields, and contains about one hundred and eighty-one square miles. It extends from Mauch Chunk, on the Lehigh river, on the northeast, to Dauphin on the Susquehanna river, on the southwest. Its greatest width, at Pottsville, is eight miles, from which it gradually tapers toward the northeast and the southwest, and in the latter direction divides into 2 long narrow basins.

The Western Middle basin.—The Western Middle basin lies southwest of and adjoins the Eastern Middle. It is north of and approximately parallel with the Southern basin, to which it is contiguous for a short distance. This basin is 36 miles long, from 4 to 5 miles wide, and contains 94 square miles underlain by coal. In this basin there are 2 distinct sub-basins or divisions, known as the Mahanoy and the Shamokin, which are about equal in size, depth, and importance.

The Southern and the Western Middle basins together form what is known as the Schuylkill Trade region. The first shipments from this region, as far as known, were made in 1822, two years after the first coal was shipped from the Lehigh region. At the close of 1902 there had been shipped from the Schuylkill region 417,944,349 long tons, or 33.26 per cent of the entire anthracite shipments.

The following table shows the shipments of anthracite from the 3 trade regions for each year from the beginning of the industry, in 1820, to the close of 1902. These statistics are from the records maintained by the Bureau of Anthracite Coal Statistics. The figures do not include shipments from the Bernice basin, in Sullivan county, nor any coal sold to local trade or consumed at the collieries.

TABLE 12.—*Annual shipments from the Schuylkill, Lehigh, and Wyoming regions: 1820 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	TOTAL.	SCHUYLKILL REGION.		LEHIGH REGION.		WYOMING REGION.	
	Quantity (long tons).	Quantity (long tons).	Per cent.	Quantity (long tons).	Per cent.	Quantity (long tons).	Per cent.
Total	1,256,782,159	417,944,349	33.26	212,039,554	16.87	626,798,256	49.87
1820	365			365			
1821	1,073			1,073			
1822	3,720	1,480	39.79	2,240	60.21		
1823	6,951	1,128	16.23	5,823	83.77		
1824	11,108	1,567	14.10	9,541	85.90		
1825	34,893	6,500	18.60	28,393	81.40		
1826	48,047	16,767	34.90	31,280	65.10		
1827	63,434	31,360	49.44	32,074	50.56		
1828	77,516	47,284	61.00	30,232	39.00		
1829	112,083	79,973	71.35	25,110	22.40	7,000	6.25
1830	174,734	89,984	51.50	41,750	23.90	43,000	24.60
1831	176,820	81,854	46.29	40,966	23.17	54,000	30.54
1832	363,271	209,271	57.61	70,000	19.27	84,000	23.12
1833	487,749	252,971	51.87	123,001	25.22	111,777	22.91
1834	376,636	226,692	60.19	106,244	28.21	43,700	11.60
1835	560,758	339,508	60.54	131,250	23.41	90,000	16.05
1836	684,117	432,045	63.16	148,211	21.66	103,861	15.18
1837	869,441	530,152	60.98	223,902	25.75	115,387	13.27
1838	738,697	446,875	60.49	213,615	28.92	78,207	10.59
1839	818,402	475,077	58.05	221,025	27.01	122,300	14.94
1840	864,379	490,596	56.75	225,313	26.07	148,470	17.18
1841	959,773	624,466	65.07	143,037	14.90	192,270	20.03
1842	1,108,412	583,273	52.62	272,540	24.59	252,599	22.79
1843	1,263,598	710,200	56.21	267,793	21.19	285,605	22.60
1844	1,630,850	887,937	54.45	377,002	23.12	365,911	22.43
1845	2,013,013	1,131,724	56.22	429,453	21.33	451,836	22.45
1846	2,344,005	1,308,500	55.82	517,116	22.07	518,389	22.11
1847	2,882,309	1,665,735	57.79	633,507	21.98	583,067	20.23
1848	3,089,238	1,733,721	56.12	670,321	21.70	685,196	22.18
1849	3,242,966	1,728,500	53.30	781,556	24.10	732,910	22.60
1850	3,358,899	1,840,620	54.80	690,456	20.56	827,823	24.64
1851	4,448,916	2,328,525	52.34	964,224	21.68	1,156,167	25.98
1852	4,993,471	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72
1853	5,195,151	2,665,110	51.30	1,054,309	20.29	1,475,732	28.41
1854	6,002,334	3,191,670	53.17	1,207,186	20.13	1,603,478	26.73
1855	6,608,567	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80
1856	6,927,580	3,603,029	52.01	1,351,970	19.51	1,972,581	28.48
1857	6,644,941	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39
1858	6,839,369	3,273,245	47.86	1,380,030	20.18	2,186,094	31.96
1859	7,808,255	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98
1860	8,513,123	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56
1861	7,954,264	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41
1862	7,869,407	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97
1863	9,566,006	3,911,683	40.89	1,894,713	19.80	3,759,610	39.30
1864	10,177,475	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92
1865	9,652,391	4,356,959	45.14	2,040,913	21.14	3,254,519	33.72
1866	12,703,882	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29
1867	12,988,725	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99
1868	13,801,465	5,330,737	38.63	2,502,582	18.13	5,968,146	43.24
1869	13,866,180	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28
1870	16,182,191	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28
1871	15,699,721	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02
1872	19,669,778	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27
1873	21,227,952	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57
1874	20,145,121	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18
1875	19,712,472	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75
1876	18,501,011	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53
1877	20,828,179	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85
1878	17,605,262	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92
1879	26,142,689	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14
1880	23,437,242	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72
1881	28,500,017	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96
1882	29,120,096	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98
1883	31,793,027	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08
1884	30,718,293	9,478,314	30.85	5,562,226	18.11	[1] 15,677,753	51.04
1885	31,623,530	9,488,426	30.01	5,898,634	18.65	[1] 16,236,470	51.34
1886	32,136,362	9,381,407	29.19	5,723,129	17.81	[1] 17,031,826	53.00
1887	34,641,018	10,609,028	30.63	4,347,061	12.55	[1] 19,684,929	56.82
1888	38,145,718	10,654,116	27.93	5,639,236	14.78	[1] 21,852,366	57.29
1889	35,817,093	10,486,185	29.28	6,294,073	17.57	[1] 19,036,835	53.15
1890	36,615,459	10,867,822	29.68	6,329,658	17.28	[1] 19,417,979	53.04
1891	40,448,336	12,741,258	31.50	6,381,838	15.78	21,325,240	52.72
1892	41,893,340	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46
1893	43,089,537	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33
1894	41,391,200	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72
1895	46,511,477	14,269,932	30.68	7,298,124	15.69	24,943,421	53.63
1896	43,177,485	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63
1897	41,637,864	12,181,061	29.25	6,249,540	15.00	23,207,263	55.74
1898	41,899,751	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25
1899	47,665,204	14,190,009	29.77	6,887,909	14.45	26,578,286	55.76
1900	45,107,484	13,502,732	29.93	6,918,627	15.33	24,686,125	54.73
1901	53,568,601	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63
1902	31,200,890	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73

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[1] Includes Loyalsock field.

BITUMINOUS.

In 1902 the total output of the varieties of bituminous coal included in this report amounted to 260,216,844 short tons, valued at $290,858,483, as compared with 95,629,026 short tons, valued at $94,346,809, in 1889, and 42,840,751 short tons, valued at $53,466,958, in 1880.

Though the small mines numbered 826, they furnished but 196,488 tons of coal, or 0.075 per cent of the total bituminous output. They averaged 238 tons per mine, as compared with 53,879 tons, the average production of commercial mines.

A summary of the bituminous coal statistics for both commercial and small mines is presented in Table 13.

TABLE 13.—*Summary, coal, bituminous: 1902.*

	Total	Commercial mines.	Small mines.
Number of mines	5,652	4,826	826
Number of operators	4,409	3,584	825
Salaried officials, clerks, etc			
Number	14,413	14,413	......
Salaries	$14,511,924	$14,511,924	......
Wage-earners:			
Average number	280,638	280,205	433
Wages	$181,482,288	$181,347,208	$135,080
Contract work	$1,244,114	$1,242,239	$1,875
Miscellaneous expenses	$16,774,459	$16,770,185	$4,274
Cost of supplies and materials	$24,798,922	$24,780,695	$18,227
Product:			
Quantity, short tons	260,216,844	260,020,356	196,488
Value	$290,858,483	$290,584,483	$274,000

Capital stock of incorporated companies.—The following table shows the details of capitalization of the incorporated companies operating bituminous coal mines for the United States, by states and territories:

TABLE 14.—COAL, BITUMINOUS—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Alabama.	Arkansas.	California.	Colorado.	Georgia.	Illinois.	Indian Territory.	Indiana.
Number of incorporated companies	1,517	63	19	7	35	2	201	[illegible]	93
Number reporting capitalization	1,450	60	19	7	32	2	194	19	91
Capital stock and bonds issued	$655,718,025	$51,572,770	$8,323,325	$8,320,000	$57,423,211	$600,000	$30,509,600	$4,931,500	$5,902,275
Capital stock:									
Total authorized—									
Number of shares	29,806,983	1,308,337	73,828	1,853,500	6,256,330	500	317,995	81,220	95,366
Par value	$594,106,570	$44,920,700	$6,492,800	$8,950,000	$50,488,000	$320,000	$28,037,400	$4,964,000	$6,151,000
Total issued—									
Number of shares	19,309,014	835,061	71,119	1,532,500	5,008,521	500	300,316	67,545	81,575
Par value	$513,424,186	$37,312,770	$6,424,325	$7,820,000	$34,464,461	$320,000	$26,606,100	$4,349,500	$5,310,275
Dividends paid	$17,359,841	$529,582	$325,609	$5,000	$1,083,506	$143,680	$680,488	$1,650	$161,336
Common—									
Authorized									
Number of shares	28,415,568	1,158,687	58,909	1,853,500	6,233,330	500	309,415	81,220	95,276
Par value	$518,756,363	$36,021,700	$5,000,900	$8,950,000	$48,188,000	$320,000	$27,179,400	$4,964,000	$6,142,000
Issued—									
Number of shares	18,037,548	757,784	56,200	1,532,500	4,986,371	500	291,806	67,545	81,495
Par value	$443,749,259	$31,091,400	$4,932,425	$7,820,000	$32,249,461	$320,000	$25,755,100	$4,349,500	$5,302,275
Dividends paid	$13,297,536	$112,292	$251,014	$5,000	$923,506	$143,680	$677,828	$1,650	$161,096
Preferred—									
Authorized									
Number of shares	1,391,415	149,650	14,919	......	23,000	......	8,580	......	90
Par value	$75,350,207	$8,899,000	$1,491,900	......	$2,300,000	......	$858,000	......	$9,000
Issued—									
Number of shares	1,271,466	77,277	14,919	......	22,150	......	8,510	......	80
Par value	$69,674,927	$6,221,370	$1,491,900	......	$2,215,000	......	$851,000	......	$8,000
Dividends paid	$4,062,305	$417,290	$74,595	......	$160,000	......	$2,660	......	$240
Bonds									
Authorized									
Number	294,157	16,111	1,990	500	25,565	300	4,872	2,600	2,110
Par value	$153,493,556	$16,111,100	$1,990,000	$500,000	$23,012,700	$300,000	$4,135,000	$800,000	$695,000
Issued—									
Number	189,480	14,260	1,899	500	23,502	280	4,038	2,382	1,902
Par value	$142,293,839	$14,260,000	$1,899,000	$500,000	$22,958,750	$280,000	$3,903,500	$582,000	$592,000
Interest paid	$5,115,828	$808,049	......	$30,000	$1,069,469	$12,570	$210,576	......	$16,720
Assessments levied	$2,303,061	......	......	$325,000	$12,000	......	$395,660	$56,372	$63,700

	Iowa.	Kansas.	Kentucky.	Maryland.	Michigan.	Missouri	Montana.	New Mexico.	North Dakota.	Ohio
Number of incorporated companies	89	30	93	23	21	46	8	12	8	179
Number reporting capitalization	88	27	88	23	19	46	8	11	7	166
Capital stock and bonds issued	$7,273,410	$4,642,500	$9,893,300	$21,456,100	$971,625	$2,384,400	$4,447,140	$7,143,800	$2,010,000	$41,598,170
Capital stock:										
Total authorized—										
Number of shares	791,907	43,062	191,620	1,628,400	45,680	35,284	780,500	58,700	32,000	508,519
Par value	$7,697,500	$4,258,700	$12,908,000	$20,690,000	$1,002,000	$2,240,400	$8,690,000	$5,870,000	$2,300,000	$34,854,900
Total issued—										
Number of shares	620,417	38,243	137,594	614,415	11,465	33,750	588,450	56,438	29,000	474,894
Par value	$6,630,410	$3,776,800	$8,968,400	$17,606,100	$971,625	$2,221,400	$4,447,140	$5,643,800	$2,010,000	$32,491,170
Dividends paid	$163,987	$174,010	$327,092	$562,750	$7,200	......	$300,000	$44,760	......	$780,697
Common—										
Authorized—										
Number of shares	575,484	42,062	189,320	1,428,150	45,280	35,084	780,500	53,700	32,000	485,889
Par value	$5,517,520	$4,158,700	$12,868,000	$18,665,000	$992,000	$2,220,400	$8,690,000	$5,370,000	$2,300,000	$33,761,900
Issued—										
Number of shares	404,085	37,243	135,394	425,670	11,065	33,550	588,450	51,438	29,000	457,072
Par value	$4,451,340	$3,676,800	$8,928,400	$15,696,600	$961,625	$2,201,400	$4,447,140	$5,143,800	$2,010,000	$31,881,670
Dividends paid	$162,937	$174,010	$325,892	$430,800	$6,000	......	$300,000	$4,760		$778,827
Preferred—										
Authorized										
Number of shares	216,423	1,000	2,300	200,250	400	200	......	5,000	......	22,630
Par value	$2,179,980	$100,000	$40,000	$2,025,000	$10,000	$20,000	......	$500,000	......	$1,093,000
Issued—										
Number of shares	216,332	1,000	2,200	188,745	400	200	......	5,000	......	17,822
Par value	$2,179,070	$100,000	$40,000	$1,909,500	$10,000	$20,000		$500,000	......	$609,500
Dividends paid	$1,050	......	$1,200	$131,950	$1,200	......		$40,000	......	$1,870
Bonds:										
Authorized—										
Number	776	1,641	2,166	33,250	......	1,613	......	1,500	......	12,885
Par value	$888,000	$865,700	$1,071,200	$4,000,000	......	$163,000	......	$1,500,000	......	$11,445,000
Issued—										
Number	617	1,641	1,981	33,100	......	1,613	......	1,500	......	9,981
Par value	$643,000	$865,700	$924,900	$3,850,000	......	$163,000	......	$1,500,000	......	$9,107,000
Interest paid	$17,780	$4,620	$23,001	$222,000	......	$10,180	......	$75,000	......	$341,789
Assessments levied	$8,000	......	$153,501	......	......	$40,000	......	......	......	$253,000

TABLE 14.—COAL, BITUMINOUS—CAPITALIZATION OF INCORPORATED COMPANIES: 1902—Continued.

	Oregon.	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wyoming.	All other states and territories.[1]
Number of incorporated companies	[illegible]	236	50	17	5	11	17	216	12	2
Number reporting capitalization	3	225	48	17	5	11	16	206	10	2
Capital stock and bonds issued	$1,512,500	$225,919,033	$12,365,549	$4,252,300	$14,529,000	$2,505,000	$48,082,503	$69,931,014	$4,819,000	$2,399,000
Capital stock										
Total authorized—										
Number of shares	15,500	2,813,003	438,777	42,588	125,700	26,210	10,975,242	971,591	282,720	18,004
Par value	$1,550,000	$194,338,450	$10,273,820	$3,943,000	$12,570,000	$2,616,000	$43,729,200	$67,724,100	$4,722,000	$1,804,000
Total issued—										
Number of shares	15,125	2,585,468	379,878	40,911	125,700	22,060	4,479,957	823,418	282,690	18,004
Par value	$1,512,500	$180,338,033	$9,883,889	$3,775,300	$12,570,000	$2,205,000	$33,075,671	$56,163,514	$4,719,000	$1,804,000
Dividends paid	....	$8,978,084	$208,643	$145,000	$172,800	$120,000	$628,812	$1,666,155	$149,000	....
Common—										
Authorized—										
Number of shares	15,500	2,275,650	350,191	42,588	125,700	25,710	10,868,812	958,391	282,720	17,000
Par value	$1,550,000	$146,805,783	$9,599,160	$3,943,000	$12,570,000	$2,566,000	$37,586,200	$66,404,100	$4,722,000	$1,700,000
Issued—										
Number of shares	15,125	2,064,563	303,906	40,911	125,700	21,560	4,374,707	810,218	282,690	17,000
Par value	$1,512,500	$134,837,550	$9,363,785	$3,775,300	$12,570,000	$2,155,000	$27,050,671	$54,843,514	$4,719,000	$1,700,000
Dividends paid	....	$6,023,337	$199,390	$145,000	$172,800	$120,000	$372,562	$1,656,155	$149,000	....
Preferred—										
Authorized—										
Number of shares	....	537,353	88,586	....	....	500	106,430	13,200	....	1,004
Par value	....	$47,532,667	$674,660	....	....	$50,000	$6,143,000	$1,320,000	....	$104,000
Issued—										
Number of shares	....	520,905	75,972	....	....	500	105,250	13,200	....	1,004
Par value	....	$45,500,483	$520,104	....	....	$50,000	$6,025,000	$1,320,000	....	$104,000
Dividends paid	....	$2,954,747	$9,253	....	....	....	$256,250	$10,000	....	....
Bonds:										
Authorized—										
Number	....	49,643	12,052	1,670	2,050	780	7,216	20,194	640	1,060
Par value	....	$47,847,667	$3,015,660	$479,000	$2,050,000	$330,000	$16,176,829	$15,238,000	$100,000	$810,000
Issued—										
Number	....	46,142	11,518	4,566	1,959	480	6,066	16,915	640	845
Par value	....	$45,581,000	$2,481,660	$477,000	$1,959,000	$300,000	$15,006,829	$13,767,500	$100,000	$595,000
Interest paid	....	$1,803,381	$137,297	$16,884	$77,727	$18,000	$851,350	$685,005	$5,400	$14,260
Assessments levied	$10,000	$27,600	$129,504	$78,985	$3,150	....	$411,780	$304,800	....	....

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[1] Includes incorporated companies distributed as follows: Alaska, 1; North Carolina, 1.

According to this table the total number of shares, common and preferred, issued and outstanding, by incorporated bituminous coal mining companies operating in 1902, and reporting capitalization, was 19,309,014, having a par value of $513,424,186, on which dividends were paid to the amount of $17,359,841, or 3.38 per cent on the par value of the stock issued. Deducting assessments levied, $2,303,061, the net dividends paid amounted to $15,056,780, or 2.93 per cent on the capital stock.

There were 1,517 incorporated companies engaged in this branch of the coal industry, and of these 67 did not report capitalization. These nonreporting incorporated companies were distributed among 16 of the bituminous coal states, as follows: Ohio, 13; Pennsylvania, 11; West Virginia, 10; Illinois, 7; Kentucky, 5; Alabama, Colorado, and Kansas, each 3; Indiana, Michigan, Texas, and Wyoming, each 2; and Iowa, New Mexico, North Dakota, and Washington, 1 each. No dividends were reported as paid by the companies operating in Alaska, Missouri, North Carolina, North Dakota, and Oregon. The interest paid on bonds was $6,115,828, and the sum of $2,303,061 was paid in as assessments on capital stock.

Employees and wages.—The expenditures reported for salaries were $14,511,924, and for wages, $181,482,288.

In the following table is shown the distribution of the wage-earners according to their occupation and daily rates of pay:

TABLE 15.—COAL, BITUMINOUS—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

[Each cumulative percentage shows the proportion of total number of persons in the given class receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.			ENGINEERS.			FIREMEN.			MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		
	Average number.	Per cent of total.	Cumulative per centage.	Average number.	Per cent of total.	Cumulative per centage.	Average number.	Per cent of total.	Cumulative per centage.	Average number.	Per cent of total.	Cumulative per centage.
Total	280,638	100.0	..	3,781	100.0	....	3,112	100.0	...	6,739	100.0	....
Less than 0.50	117	(1)	100.0	....	....	....	....	....	....	....	....	....
0.50 to 0.74	1,139	0.4	99.9	....	....	....	1	(1)	100.0	4	0.1	100.0
0.75 to 0.99	2,720	1.0	99.6	3	0.1	100.0	10	0.3	99.9	5	0.1	99.9
1.00 to 1.24	8,084	2.9	98.6	8	0.2	99.9	32	1.0	99.7	42	0.6	99.8
1.25 to 1.49	11,928	4.2	95.7	46	1.2	99.7	141	4.6	98.7	175	2.6	99.2
1.50 to 1.74	32,034	11.4	91.5	165	4.4	98.5	459	14.8	94.1	393	5.8	96.6
1.75 to 1.99	36,797	13.1	80.1	248	6.6	94.1	721	23.2	79.3	601	8.9	90.8
2.00 to 2.24	70,909	25.3	67.0	977	25.8	87.5	1,108	35.6	56.1	1,400	20.8	81.9
2.25 to 2.49	43,609	15.5	41.7	754	19.9	61.7	283	9.1	20.5	1,876	27.8	61.1
2.50 to 2.74	32,454	11.6	26.2	930	24.6	41.8	255	8.2	11.4	1,129	16.8	33.3
2.75 to 2.99	15,814	5.6	14.6	241	6.4	17.2	54	1.7	3.2	419	6.2	16.5
3.00 to 3.24	12,038	4.3	9.0	303	8.0	10.8	38	1.2	1.5	479	7.1	10.3
3.25 to 3.49	6,370	2.3	4.7	50	1.3	2.8	5	0.2	0.3	65	1.0	3.2
3.50 to 3.74	4,402	1.6	2.4	34	0.9	1.5	2	0.1	0.1	76	1.1	2.2
3.75 to 3.99	1,324	0.5	0.8	6	0.2	0.6	....	....	....	8	0.1	1.1
4.00 to 4.24	495	0.2	0.3	11	0.3	0.4	....	....	....	62	0.9	1.0
4.25 and over	404	0.1	0.1	5	0.1	0.1	....	....	....	6	0.1	0.1

TABLE 15.—COAL, BITUMINOUS—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902—Continued.

RATE PER DAY (DOLLARS).	MINERS.			MINERS' HELPERS.			TIMBERMEN AND TRACK LAYERS.			BOYS UNDER 16 YEARS.			ALL OTHER WAGE-EARNERS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	189,275	100.0	....	3,637	100.0	....	7,843	100.0	....	5,628	100.0	....	60,625	100.0	....
Less than 0.50	29	(1)	100.0	....	....	....	....	....	....	86	1.5	100.0	2	(1)	100.0
0.50 to 0.74	86	(1)	99.9	7	0.2	100.0	1	(1)	100.0	828	14.7	98.5	212	0.4	99.9
0.75 to 0.99	312	0.2	99.9	184	5.1	99.8	27	0.3	99.9	1,754	31.2	83.8	395	0.7	99.6
1.00 to 1.24	2,513	1.3	99.8	337	9.3	94.7	24	0.3	99.7	2,407	42.8	52.6	2,721	4.5	98.9
1.25 to 1.49	6,016	3.2	98.5	347	9.5	85.4	209	2.7	99.4	332	5.9	9.8	4,659	7.7	94.4
1.50 to 1.74	19,083	10.1	95.3	608	16.7	75.9	650	8.3	96.7	110	1.9	3.9	10,566	17.4	86.7
1.75 to 1.99	24,892	13.1	85.2	293	8.1	59.2	691	8.8	88.4	60	1.1	2.0	9,291	15.3	69.3
2.00 to 2.24	46,582	24.6	72.1	551	15.1	51.1	2,460	31.4	79.6	39	0.7	0.9	17,842	29.4	54.0
2.25 to 2.49	28,394	15.0	47.5	311	8.5	36.0	2,760	35.2	48.2	12	0.2	0.2	9,308	15.4	24.6
2.50 to 2.74	25,968	14.7	32.5	361	9.9	27.5	525	6.7	13.0	....	....	....	3,347	5.5	9.2
2.75 to 2.99	13,053	6.9	18.8	363	10.0	17.6	277	3.5	6.3	....	....	....	1,407	2.3	3.7
3.00 to 3.24	10,240	5.4	11.9	130	3.6	7.6	182	2.3	2.8	....	....	....	666	1.1	1.4
3.25 to 3.49	6,000	3.2	6.5	141	4.0	4.0	7	0.1	0.5	....	....	....	99	0.2	0.3
3.50 to 3.74	4,210	2.2	3.3	1	(1)	(1)	28	0.4	0.4	....	....	....	51	0.1	0.1
3.75 to 3.99	1,304	0.7	1.1	....	....	....	....	....	(1)	....	....	....	6	(1)	(1)
4.00 to 4.24	398	0.2	0.4	....	....	....	....	....	(1)	....	....	....	21	(1)	(1)
4.25 and over	363	0.2	0.2	....	....	....	2	(1)	(1)	....	....	....	28	(1)	(1)

[1] Less than one-tenth of 1 per cent.

This table shows that the majority of adult wage earners received wages between $1.75 and $2.74. Including all occupations, the largest number embraced in a single rate group was reported as receiving from $2 to $2.24 per day, 25.3 per cent falling in that group. From this rate the numbers decreased regularly as the rates of pay decreased below $2 or increased above $2.24. In the class of engineers 70.4 per cent were employed at daily rates ranging from $2 to $2.74, and in the class of firemen 73.5 per cent at rates ranging from $1.50 to $2.24 per day. Of the 6,739 machinists, blacksmiths, carpenters, and other mechanics employed, 4,404, or 65.4 per cent, were paid from $2 to $2.74 per day. The miners constituted 67.4 per cent of all employees; the largest number in any rate group appear to have received from $2 to $2.24. But on account of the mining being done on a tonnage basis the daily rates of pay are largely estimates and averages. There was paid as wages for the mining of bituminous coal on a tonnage basis the sum of $128,055,854. The daily rates of pay to miners' helpers show a distribution over a much wider range than is the case with other occupations. Of the timbermen and track layers 5,220, or 66.6 per cent, were paid at rates ranging from $2 to $2.49, and 90.3 per cent received from $1.50 to $2.74 per day. The 5,628 boys under 16 years of age constituted 2 per cent of all employees; 74 per cent received from $0.75 to $1.24 per day. The remaining wage-earners, classified as "all others," comprised 60,625, and constituted 21.6 per cent of all wage-earners, and 77.5 per cent of the number were paid at daily rates ranging from $1.50 to $2.49.

As shown in Table 60 the largest number of men, for the industry as a whole, was employed in December and the smallest number in July, the maximum and minimum numbers being only about 7 per cent above and below the average number. Michigan showed a heavy falling off from April to August, but as a rule the states do not show any wide fluctuations.

Contract work.—The expenditure for contract work amounted to $1,244,114, and 5,040 men were employed thereon. This was for tunneling, shaft sinking, and like work done under contract.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials reported amounted to $24,798,922, or 10.4 per cent of all expenses, and was the largest item next to the amount paid for salaries and wages. The amount expended for miscellaneous expenses, $16,774,459, comprised $7,442,089 for royalties and rent of mine and mining plant, and $9,332,370 paid for rent of offices, taxes, and other sundries. Miscellaneous expenses formed 7 per cent of all expenses.

Production by states.—In the following table is shown the total production of bituminous coal by states during 1902, the distribution of the product for consumption, and the value and average price per ton at the mines.

TABLE 16.—COAL, BITUMINOUS—PRODUCTION, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	212,378,398	8,666,862	5,001,854	34,169,730	260,216,844	$290,858,483	$1.12
Alabama	7,271,146	78,903	244,223	2,760,298	10,354,570	12,419,666	1.20
Arkansas	1,864,912	13,639	65,381		1,943,932	2,539,211	1.31
California and Alaska	79,755	3,563	3,878		87,196	273,398	3.14
Colorado	5,375,216	282,027	181,546	1,562,555	7,401,343	8,397,812	1.13
Georgia and North Carolina	299,247	1,800	5,580	130,456	437,083	623,518	1.42
Idaho		2,030			2,030	5,180	2.50
Illinois	29,299,137	2,591,770	1,048,381	85	32,939,373	33,945,910	1.03
Indian Territory	2,587,100	25,988	96,017	111,561	2,820,666	4,265,106	1.51
Indiana	8,649,144	586,899	259,681	700	9,446,424	10,399,660	1.10
Iowa	5,089,538	678,740	136,488		5,904,766	8,660,287	1.47
Kansas	4,941,236	227,826	95,237	1,766	5,266,065	6,862,787	1.30
Kentucky	6,141,886	333,584	132,812	158,702	6,766,984	6,666,967	0.98
Maryland	5,187,175	48,631	35,803		5,271,609	5,579,869	1.06
Michigan	818,687	117,978	28,053		964,718	1,653,192	1.71
Missouri	3,503,993	318,992	67,169		3,890,154	5,374,642	1.38
Montana	1,385,100	40,719	39,023	95,981	1,560,823	2,443,447	1.57
New Mexico	973,500	19,514	33,180	22,569	1,048,763	1,500,230	1.43
North Dakota	182,002	35,639	8,870		226,511	325,967	1.44
Ohio	22,232,404	1,041,112	242,594	3,784	23,519,894	26,953,789	1.15
Oregon	42,591	11,232	11,825		65,648	160,075	2.44
Pennsylvania	72,938,204	1,429,568	1,541,454	22,665,141	98,574,367	106,032,460	1.08
Tennessee	3,417,409	88,369	63,283	813,907	4,382,968	5,399,721	1.23
Texas	887,167	5,591	9,154		901,912	1,477,245	1.64
Utah	1,277,343	21,531	45,432	230,215	1,574,521	1,797,454	1.14
Virginia	1,444,659	20,916	32,447	1,685,071	3,182,993	2,543,595	0.80
Washington	2,498,177	29,287	97,003	56,747	2,681,214	4,572,295	1.72
West Virginia	19,847,321	623,903	267,885	3,831,717	24,570,826	24,748,658	1.00
Wyoming	4,141,450	37,101	209,455	38,485	4,429,491	5,236,339	1.18

The following is a review of the production of bituminous coal in the several states and territories:

Alabama.—The coal fields of Alabama belong to the great Appalachian system, which extends from the northern part of Pennsylvania to the central part of Alabama. The coal bearing formations which become quite narrow in passing through Tennessee widen out suddenly in the northern part of Alabama and cover about 50 per cent of the northern half of the state.

The total coal area of Alabama is estimated at 6,500 square miles. There are 19 counties, all north of a line drawn midway across the state from east to west, which are underlaid by coal. In only 11 of these, however, is coal produced at present on a commercial scale. These 11 counties are Bibb, Blount, Cullman, Etowah, Jefferson, Marion, St. Clair, Shelby, Tuscaloosa, Walker, and Winston. The coal producing region is divided into 3 distinct basins or districts, which are known by the names of the rivers which drain them, the Black Warrior, the Coosa, and the Cahaba. The Warrior district is the largest, but the Cahaba is the principal producer, the county of Jefferson, which includes the city of Birmingham, in the Cahaba district, contributing more than 50 per cent of the state's total output.

All of the coals of the state are classed among the bituminous varieties. Some are coking coals of good quality, and to these is due the rapid growth of the iron and steel industries of the state. The development of these industries and of coal mining in Alabama during the last quarter of a century has been one of unusual rapidity.

The census of 1840 reported a production of coal in Alabama for that year, of 946 tons, and at the census of 1860, 10,200 tons were reported.

The distribution of the coal production, by counties, in 1902, is shown in the following table:

TABLE 17.—*Coal production of Alabama, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	7,271,146	78,903	244,223	2,760,298	10,354,570	$12,419,666	$1.20
Bibb	1,372,745	1,922	38,174	74,566	1,487,407	1,842,163	1.24
Etowah	100,290	1,280	220		101,790	125,190	1.23
Jefferson	3,410,688	56,050	160,873	2,227,915	5,855,526	6,975,929	1.19
St. Clair	119,618	550	7,500	28,575	156,243	208,162	1.33
Shelby	131,241	130	4,672		136,043	218,971	1.61
Tuscaloosa	108,617	924	1,848	320,322	431,711	527,504	1.22
Walker	1,748,078	16,047	30,936	108,920	1,903,976	2,147,894	1.13
Winston	26,686	2,000			28,686	41,250	1.44
Blount, Cullman, and Marion	253,178				253,178	332,603	1.31

According to the Census report of 1870, the production for that year was 13,200 short tons. The output did not reach 100,000 tons until 1876, but in 1880, according to the Tenth Census, it had increased to 323,972 tons. From 1882 to 1885 there was a rapid increase in production, until at the height of the Birmingham boom, in 1885, it reached a total of 2,492,000 short tons.[1] With the bursting of the bubble and the temporary collapse of the boom, production fell off to less than 2,000,000 tons in 1886 and 1887, but as trade conditions became settled the coal mining industry improved and since 1888 has shown an almost continual growth in production. At the Eleventh Census, in 1889, the production amounted to 3,572,983 tons, about eleven times what it was in 1880. In 1902 it reached the maximum, the output being 10,354,570 short tons. The selling value of this product at the mines was $12,419,666.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 353.

The amount paid in wages in 1902 was $7,841,457, salaries amounted to $709,449, contract work cost $265,579, miscellaneous expenses amounted to $734,972, and $1,219,310 was expended in the purchase of supplies and materials.

A summary of the statistics, by counties, is given in the following table, only those counties being reported separately which produce a total of 200,000 tons:

TABLE 18.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	145	91	623	$709,449	12,930	$7,841,457	$265,579	1,411	$734,972	$1,219,310	10,354,570	$12,419,666
Bibb	8	8	75	88,541	1,712	1,207,118	....	....	152,446	201,134	1,487,407	1,842,163
Jefferson	48	23	279	368,465	6,954	4,259,712	261,174	1,393	343,209	784,005	5,856,536	6,975,929
Tuscaloosa	11	7	44	36,406	722	360,660	250	4	7,493	21,699	431,711	527,504
Walker	43	29	152	149,179	2,313	1,410,396	....	....	173,512	148,886	1,903,976	2,147,894
Other counties[1]	35	24	73	66,858	1,229	603,561	4,155	14	58,312	63,586	675,940	926,176

[1] Includes Blount, Cullman, Etowah, Marion, St. Clair, Shelby, and Winston.

Alaska.[1] There are a number of localities in the territory of Alaska where coal seams of workable thickness and quality have been located, but it has been impossible to secure exact statistics in regard to the production. Mr. Alfred H. Brooks, of the United States Geological Survey, in his report entitled "The Coal Resources of Alaska,"[2] states that the coal mines of Alaska which have produced some coal in the past may be divided naturally into three separate provinces or districts—the Pacific coast district, the Yukon district, and the Arctic coast district. The Pacific coast district includes all the mines located on Pacific coast waters and one deposit at Kootznahoo bay, one at Controller bay, one at Homer (on Cook inlet), and three on the Alaskan peninsula—at Chignik river, Herendeen bay, and Unga Island. The Yukon district includes all the mines on or near the Yukon river. Of these there are six, three of which—known, respectively, as No. 1, Williams, and Blatchford—are on the Yukon river, between Anvik and Nulato; the Pickart mine is located a short distance northeast of Nulato, on the Yukon river; the Drew mine near Rampart; and Nation River mine, between Fort Yukon and Fortymile. The Arctic coast district includes two mines, the Corwin and the Thetis, located on the Arctic ocean near the seventieth degree of north latitude. Mr. Brooks states that at the time of his visit to the region, in 1902, the mine on Kootznahoo bay, the only one in southeastern Alaska, had been shut down. He also reports that at Controller bay, 30 miles east of the mouth of the Copper river, an excellent coal has been discovered, and extensive preparations are under way for developing the field. It is probable that this mine will become a producer within a short time.

The only mines in American territory from which any production was reported for 1902 were the Williams mine, on the Yukon river below Kaltag, and the Homer property, on Cook inlet. The first mentioned property produced, in 1902, 1,700 tons of coal, which was used principally on the steamers plying on the Yukon river. The Pickart mine, also on the Yukon river, was operated for a short time during 1902, but was closed down in July. No exact information as to the amount of coal obtained during this time has been secured. The Homer mine, on Cook inlet, produced 512 tons, most of which was obtained in the course of the development of the property. At this point a railway about 7 miles in length connects the mine with the navigable waters of Cook inlet, where docks and coal bunkers have been established. The three mines on the Alaskan peninsula have been operated at different times during the last two decades, but no production was reported from them in 1902, although the one on Chignik river is known to have produced some coal to supply the local steamers, and the same is true of the one on Unga Island. A company was organized during 1902 to extend the developments of the mines on Herendeen bay, but no production was reported from it during the year. The two mines in the Arctic coast district have been worked from time to time during the last twenty years to supply whalers and revenue cutters, but the operations have never reached the dignity of an industry, and no record of their actual production has been secured. Some attempt, however, at systematic development has been recently made, and a small amount of coal was shipped to Nome, where it was said to have brought a good price.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902.

[2] Twenty-second Annual Report of the United States Geological Survey, Part III.

Mr. Arthur J. Collier, assistant geologist, United States Geological Survey, who made a special investigation of the coal resources of the Yukon, has published his results in Bulletin No. 218.

During the field season of 1902 Mr. Collier was able to secure more definite data in regard to the production of the different mines along the Yukon river than have heretofore been obtained. He states that the Williams mine, on the Yukon river, 50 miles below Kaltag, which was first known as the Thein mine, was the only mine in American territory on the Yukon which was worked continuously during the season of 1902. This mine was opened in 1900 and produced some coal in that year.

The Pickart mine, 10 miles above Nulato, was opened in 1898, and produced some coal each year from that time until 1902, when it was abandoned. No definite statement as to the amount of coal produced during this time has been obtained, but the output was probably between 2,000 and 3,000 tons. The first mine to be opened on the Yukon river was what is known as the Nation River mine, 52 miles below the international boundary. About 2,000 tons of coal are said to have been produced from this mine in 1897; the mine has since been shut down and is not now operated. The next mine to be opened was what is known as the Drew mine, about 25 miles above Rampart. This mine was worked from 1897 to 1900, during which time the entire production is estimated to have amounted to about 1,200 tons. The Blatchford mine, 9 miles below Nulato, was opened in 1898 and produced some coal in 1899, 1900, and 1901. It is estimated that about 300 tons were produced at this mine during these years. What is known as Mine No. 1, about 25 miles below the Williams mine, was worked during the winter of 1898, and produced about 900 tons. Since that time it has been shut down. Mr. Collier estimates that the total amount of coal produced in American territory on the Yukon from 1897 to 1902, inclusive, is about 9,000 tons—this total being distributed annually approximately as follows:

Production of coal on the Yukon river: 1897 to 1902.

YEAR	Name of mine	Quantity (short tons)	Value
1897	Nation River	2,000	$28,000
1898	No. 1, Drew, and Pickart	1,600	22,400
1899	Drew, Pickart, and Blatchford	1,200	16,800
1900	Drew, Pickart, Blatchford, and Thein	1,200	16,800
1901	Pickart, Blatchford, and Thein	1,300	15,600
1902	Williams	1,700	17,000

All of these mines are located immediately on the Yukon river. The coal from them has been used principally on the river steamers, though a smaller amount has been used for domestic purposes at Dawson and other points along the river. At Dawson the coal sells at from $15 to $20 per ton. Coal delivered at the river banks from the Yukon mines sells for from $10 to $12 per ton at present, though in years past prices have been higher, and in 1900 coal was selling for $15 per ton at the Drew mine. Adding the production of the Cook inlet mine to that of the Williams mine in 1902, the total production reported for the territory is found to be 2,212 tons, valued at $19,048. It is known, however, that some coal was also produced at the Corwin mine, at Chignik, and at Herendeen bay, but since no definite reports have been obtained from these localities they are not included in the above statement. The actual production in the territory for 1902 was, therefore, probably somewhat larger than that reported.

Arkansas.—According to Mr. Joseph A. Taff, of the United States Geological Survey, the Arkansas coal field is a direct continuation of the Indian Territory coal field, and extends from the western line of the state in an easterly direction about 75 miles. It follows the valley of the Arkansas river, which passes from west to east about the middle of the main basin.

The north edge of the field lies upon the southern foothills of the Boston mountains, which form the southern limit of the Ozark uplift. The southern border of the field is near the Ouachita mountain ridges, which extend from the vicinity of Little Rock westward into Indian Territory.

The coals vary from bituminous to semianthracite, the latter having a high reputation as a smokeless domestic fuel, its smokeless qualities causing it to be received with great favor in the cities of the Mississippi valley. It burns with a short, hot flame and leaves a comparatively small amount of ash.

The census of 1860 reported the production of 200 tons of coal for Arkansas, but the reports of the Ninth Census contained no account of production for this state. The production for 1880 was small, 14,778 short tons, having a value of $33,535. The wages paid amounted to $20,850. In 1889, at the taking of the Eleventh Census, the production amounted to 279,584 short tons, valued at $395,836. In 1902 the production had grown to 1,943,932 short tons, valued at $2,539,214.

The statistics of production in 1902, by counties, are given in the following table:

TABLE 19.—*Coal production of Arkansas, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	1,864,912	13,639	65,381	1,943,932	$2,539,214	$1.31
Franklin	327,418	1,199	9,396	338,013	377,791	1.12
Johnson	186,812	1,072	5,374	193,258	404,822	2.09
Logan	19,286	1,215	1,250	21,751	36,000	1.66
Pope	29,399	500	5,077	34,976	101,474	2.90
Sebastian	1,275,324	6,053	43,804	1,325,181	1,583,211	1.19
Ouachita and Scott	26,673	3,600	480	30,753	35,916	1.17

In the following table is presented a summary of the statistics in connection with the coal production of Arkansas:

TABLE 20.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	53	33	146	$148,113	2,574	$1,780,061	$485	5	$82,949	$177,716	1,943,932	$2,539,214
Sebastian	27	14	84	98,371	1,650	1,180,617	485	5	64,342	128,486	1,325,181	1,583,209
Other counties[1]	26	19	62	49,742	924	599,444			18,607	49,230	618,751	956,005

[1] Includes Franklin, Johnson, Logan, Ouachita, Pope, and Scott. (Franklin county had a production exceeding 200,000 tons, but is not shown separately in order to avoid disclosing the operations of individual operators.)

California.—All of the coal mined in both California and Oregon is of the lignite variety. In California there are a number of rather widely separated fields, the chief of which are the Mt. Diablo and Corral Hollow. The principal production in 1902 was from Alameda and Contra Costa counties, the former producing about 80 per cent of the state's total output. Smaller amounts were mined in Kern, Monterey, Riverside, and Siskiyou counties. In a number of other counties coal veins have been prospected, and the counties of Amador, Butte, Del Norte, Fresno, Orange, and San Diego have produced some lignite coal in the past. These mines, however, have been abandoned from one cause or another, principally the quality of the coal, although there was also difficulty in the mining. The Corral Hollow field, which is the one in Alameda county, has a considerable advantage, on account of its proximity to San Francisco, where the product finds its principal market. The total production of lignite in California during 1902 was only 84,984 short tons, as compared with 119,820 short tons in 1889.

The comparatively small coal mining industry of California is subjected to influences which do not affect other states. One of these is the exportation of wheat from the Pacific seaports. Vessels carrying wheat as an outgoing cargo are apt to bring back, at a low rate of freight, coals from Australia or Japan. When such is the case the demand for California coal falls off. In the years 1899, 1900, and 1901, according to the reports of the United States Geological Survey, occurred the largest outputs of coal in the state of California since 1880. The production in 1902 was reduced much below that of these years on account of the large production of crude petroleum, the use of which for fuel purposes in the manufacturing industries of the state developed very rapidly in 1902.

Colorado.—The coal fields of Colorado have been fully described by Mr. R. C. Hills, in Mineral Resources of the United States, 1892. They have also been described in considerable detail by Mr. L. S. Storrs in the Twenty-second Annual Report of the United States Geological Survey, Part III. Geologically, the coal bearing rocks of Colorado are confined to the Upper Cretaceous coal measures and, with only few exceptions, to the Laramie formation in these measures. The coal bearing territory is found along both the eastern and western flanks of the Rocky mountains.

The coal producing areas are divided into 3 groups, the Eastern, Park, and Western, the fields of each group being separated by areas of great elevation and erosion. The groups are again subdivided into distinct fields, as follows: The Eastern group into the Raton, Canyon City, and South Platte; the Park group into the Middle Park and Como; and the Western group into the Yampa, Grand river, and La Plata.

The coal fields of Colorado contain every variety of coal, from the typical lignite to the true anthracite. The area of the latter, however, is very small, Mr. Storrs stating that it probably does not exceed 80 square miles.

Owing to the aggressive policy of the Colorado Fuel and Iron Company, the coal fields of Colorado have been more thoroughly explored than those of any other state in the Rocky mountain region. Mr. Hills, in his report on Mineral Resources of the United States, 1892, estimates the available gross tonnage of the Colorado fields at 45,197,100,000 short tons, and estimating 75 per cent of this as recoverable, the net available supply is placed at 33,897,800,000 tons.

The production of the state in 1902, by counties, with the distribution of the product for consumption, was as follows:

TABLE 21.—*Coal production of Colorado, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	5,375,215	282,027	181,546	1,562,555	7,401,343	$8,397,812	$1.13
Boulder	719,584	48,454	38,333		806,371	1,019,072	1.26
Delta	410	8,790	150		9,350	12,450	1.33
El Paso	74,135	140,714	3,700		218,549	286,279	1.31
Fremont	661,804	2,559	31,636		695,999	1,146,416	1.65
Garfield	200,821	2,351	4,090		207,262	228,935	1.10
Gunnison	252,861	1,519	8,611	101,880	364,871	563,593	1.54
Huerfano	1,156,555	1,891	27,867		1,190,313	1,446,866	1.22
La Plata	143,412	10,178	607	832	155,029	230,901	1.49
Las Animas	1,929,116	26,250	55,435	1,234,470	3,245,271	2,919,146	0.90
Routt	600	2,535	45		3,180	4,698	1.48
Weld	38,652	30,102	4,627		73,681	106,574	1.45
Other counties[1]	197,295	3,384	6,412	225,373	432,464	432,891	1.00

[1] Includes Arapahoe, Larimer, Mesa, Montezuma, Ouray, Pitkin, and Rio Blanco.

Coal mining operations, as far as known, began in Colorado in 1864, the production in that year amounting to 500 tons. In 1870 the amount produced was 5,040 short tons, and at the taking of the Tenth Census the production amounted to 462,747 tons. In 1889 it had increased to 2,544,144 tons, and in 1902 it amounted to 7,401,343 tons. The United States Geological Survey estimates that the total amount of coal produced in Colorado from 1864 to the close of 1902 was 68,842,054 tons, or about one-fifth of 1 per cent of the net available supply estimated by Mr. Hills.

During 1902 coal was produced in Colorado in 18 counties, but in 7 of these there were not more than 2 establishments, so that the statistics of these 7 have been combined.

The following table is a summary of the statistics by counties where the production was 200,000 short tons:

TABLE 22.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	126	80	611	$818,445	7,955	$6,006,183	$14,413	98	$681,494	$1,039,831	7,401,343	$8,397,812
Boulder	18	10	46	55,126	832	617,864	2,394	9	76,229	89,188	806,371	1,019,072
El Paso	9	7	41	35,296	278	168,865	425	5	27,540	20,454	218,549	286,270
Fremont	6	3	33	58,234	965	705,643			85,769	109,173	695,999	1,146,416
Garfield	7	6	21	22,050	175	144,601	4,300	6	6,709	137,951	207,262	228,985
Gunnison	6	3	18	31,852	386	326,566			40,867	45,795	364,874	563,593
Huerfano	15	6	97	123,612	1,266	998,242			108,501	217,506	1,189,313	1,446,866
Las Animas	21	7	256	365,809	3,409	2,502,328	6,104	17	288,759	341,616	3,245,271	2,919,146
Other counties[1]	44	38	99	126,437	644	542,054	1,190	61	47,060	78,148	673,704	787,514

[1] Includes Arapahoe, Delta, La Plata, Larimer, Mesa, Montezuma, Ouray, Pitkin, Rio Blanco, Routt, and Weld. (Pitkin county had a production exceeding 200,000 tons, but is not shown separately in order to avoid disclosing the operations of individual operators.)

Illinois.—The coal fields of Illinois form by far the greater portion of the great Central coal field which underlies the larger part of Illinois, the southwestern part of Indiana, and several counties of western Kentucky.

Nearly three-fourths of the state of Illinois is underlaid by productive coal measures, the entire area being estimated at 42,900 square miles. This is the largest coal bearing area recorded for any state of the Union. There are more counties in this state in which coal is produced than in any other of the United States, the production in 1902 being reported from 54 different counties. In 9 of these the production exceeded 1,000,000 tons, and in 9 more the production was between 500,000 and 1,000,000 tons. The coal is principally bituminous, of the dry, noncoking variety.

In 1902 the state was the second in importance among the coal producing states, being outranked only by Pennsylvania. Its production was 10.9 per cent of the total production of the United States; the value was 9.2 per cent of the total value. The output in 1902 amounted to 32,939,373 short tons, valued at $33,945,910. At the taking of the Eleventh Census the production of coal in Illinois was 12,104,272 short tons, worth at the mines $11,755,203. The total production of the state during the census year 1880 was 6,115,377 short tons, valued at $8,779,832.

The expenditures reported were: For salaries, $1,564,832; for wages, $24,876,201; for contract work, $24,699; for miscellaneous expenses, $1,258,686; and for supplies and materials, $2,834,444. The incorporated companies paid $680,488 in dividends on capital stock, and $210,556 in interest on bonds.

The production by counties and the disposition of the product are shown in Table 23.

TABLE 23.—*Coal production of Illinois, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	29,299,137	2,591,770	1,048,381	85	32,939,373	$33,945,910	$1.03
Brown		1,230			1,230	1,705	1.39
Bureau	1,653,131	55,132	61,379		1,769,642	2,401,435	1.36
Christian	815,601	77,157	43,278		936,036	890,512	0.95
Clinton	795,793	13,092	25,433		834,318	771,246	0.92
Fulton	871,108	58,374	24,125		953,607	1,104,963	1.16
Gallatin	18,325	11,971	615		30,911	35,090	1.13
Greene		6,000			6,000	9,265	1.54
Grundy	1,328,815	47,962	37,702		1,414,479	1,880,231	1.33
Hancock	1,570	11,800	30		13,400	22,800	1.70
Henry	44,888	89,859	3,565		138,312	229,509	1.66
Jackson	857,193	27,700	45,594		930,487	1,023,853	1.10
Jersey		3,520			3,520	5,490	1.56
Johnson	200	3,650			3,850	4,195	1.09
Knox	36,540	48,481	830		85,851	128,067	1.49
Lasalle	1,487,507	304,862	53,867		1,846,236	2,369,459	1.28
Livingston	299,012	85,618	10,453		395,083	544,581	1.38
Logan	218,500	35,132	15,075		268,707	302,894	1.13
McDonough	20,353	14,133	150		34,636	57,997	1.67
McLean	77,000	90,200	7,800		175,000	254,775	1.46
Macoupin	2,033,159	66,419	85,747		2,185,325	1,911,377	0.87
Madison	2,232,236	58,119	84,329		2,374,684	1,941,599	0.82
Marion	841,127	37,553	43,976		922,656	787,737	0.85
Marshall	421,467	19,313	17,416		458,196	611,491	1.33
Menard	419,067	29,516	23,375		471,958	473,369	1.00
Mercer	577,148	38,837	24,156		640,141	766,725	1.20
Montgomery	558,590	46,113	14,745		619,448	641,042	1.03
Morgan		1,775	5		1,780	7,170	1.59
Peoria	723,411	113,554	15,325	85	852,375	963,519	1.13
Perry	931,406	34,078	25,860		991,344	925,131	0.93
Randolph	431,131	18,653	7,190		456,984	377,318	0.83
Rock Island	50,253	31,490	1,675		83,418	120,569	1.45
St. Clair	2,537,147	188,451	96,650		2,822,248	2,425,846	0.86
Saline	278,662	13,279	5,630		297,571	277,308	0.93
Sangamon	3,669,213	379,192	124,317		4,172,722	3,865,742	0.92
Schuyler	2,520	15,877	60		18,457	23,661	1.28
Scott	15,990	10,945	500		27,435	42,168	1.54
Shelby	58,866	19,310	8,936		87,112	178,039	2.04
Stark	6,640	21,833	570		29,043	48,162	1.66
Tazewell	97,089	72,174	3,755		173,018	198,891	1.15
Vermilion	2,330,765	210,013	14,543		2,555,291	2,546,608	0.99
Warren	2,200	13,577	300		16,077	27,935	1.74
Washington	38,754	14,951	3,130		56,835	55,105	0.97
Will	25,125	14,357	1,310		40,792	73,012	1.79
Williamson	2,229,073	31,682	65,187		2,325,942	2,116,290	0.91
Other counties[1]	262,632	101,796	19,798		384,226	501,839	1.31

[1] Includes Bond, Calhoun, Cass, Edwards, Hamilton, Jefferson, Kankakee, Macon, Wabash and Woodford.

A summary of the statistics by counties having a production of 200,000 tons or over is given in the following table:

TABLE 24.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	875	789	1,510	$1,564,852	36,617	$24,876,201	$24,699	132	$1,258,696	$2,834,444	32,939,373	$33,945,910
Bureau	20	16	45	64,230	3,068	1,831,803	....	....	85,362	221,657	1,769,642	2,401,635
Christian	7	7	39	41,754	919	659,493	....	....	20,464	86,887	936,086	890,512
Clinton	6	3	23	25,032	789	502,444	....	....	9,395	68,507	884,318	771,246
Fulton	48	41	66	50,221	1,155	756,818	1,068	10	48,971	113,120	953,607	1,104,968
Grundy	24	18	52	65,230	2,856	1,568,311	1,328	8	32,807	144,843	1,414,479	1,880,231
Jackson	18	17	51	53,009	885	655,555	2,325	7	101,626	88,469	990,487	1,023,853
Lasalle	35	30	93	96,069	3,010	1,773,672	....	....	40,153	225,402	1,846,236	2,869,339
Livingston	14	14	17	16,259	484	350,457	46	1	16,101	95,147	805,063	544,581
Logan	5	5	19	19,195	304	240,243	....	....	8,404	31,313	268,707	302,894
Macoupin	16	10	83	104,567	1,871	1,402,687	....	....	41,586	177,647	2,185,325	1,911,377
Madison	30	22	125	119,690	2,280	1,569,367	540	6	69,537	148,659	2,374,684	1,941,599
Marion	7	6	33	44,135	840	598,540	....	....	8,268	102,631	922,656	787,787
Marshall	10	8	24	26,935	796	467,596	....	....	32,466	34,037	458,168	611,491
Menard	13	13	32	27,122	616	375,091	3,800	12	20,817	54,295	471,968	473,369
Mercer	16	16	21	26,600	766	598,458	....	....	4,730	49,160	640,141	766,725
Montgomery	5	5	21	18,500	457	383,098	....	....	11,330	38,379	619,448	641,042
Peoria	65	63	38	40,417	872	639,769	485	9	58,787	97,883	852,375	963,519
Perry	19	15	66	68,612	1,111	721,983	....	....	40,633	68,596	991,844	925,131
Randolph	15	16	20	17,138	357	296,324	2,244	10	14,451	23,814	456,984	377,318
St. Clair	69	53	167	157,094	2,235	1,709,516	4,500	7	97,165	153,898	2,822,248	2,425,846
Saline	17	17	17	16,465	211	162,523	200	3	12,398	28,603	297,571	277,308
Sangamon	30	22	177	175,031	3,759	2,865,988	4,142	22	166,400	281,917	4,172,722	3,865,742
Vermilion	63	57	69	71,242	2,678	1,832,935	710	5	64,800	248,223	2,565,291	2,548,608
Williamson	38	35	98	118,530	1,874	1,372,351	100	1	127,378	166,117	2,325,942	2,116,290
Other counties[1]	285	282	114	101,126	2,521	1,460,293	3,211	36	139,771	143,990	1,413,903	2,025,744

[1] Includes Bond, Brown, Calhoun, Cass, Edwards, Gallatin, Greene, Hamilton, Hancock, Henry, Jefferson, Jersey, Johnson, Kankakee, Knox, McDonough, McLean, Macon, Morgan, Rock Island, Schuyler, Scott, Shelby, Stark, Tazewell, Wabash, Warren, Washington, Will, and Woodford.

Indian Territory.—The coal areas of Indian Territory form a portion of the Western coal field, and are directly connected with the coal fields of Kansas on the north and those of Arkansas on the east.

The greater portion of the development has been in the Choctaw nation, in the territory tributary to the Missouri, Kansas and Texas Railway and the St. Louis and San Francisco Railroad, which cross the territory from north to south, and to the Choctaw, Oklahoma and Gulf Railroad, crossing it from east to west. Workable areas also underlie about half of the Cherokee nation, all of the Creek nation, and the northeast corner of the Chickasaw nation. The area underlaid by workable seams is estimated to contain about 14,848 square miles.

The entire production in the territory was from the Cherokee and Choctaw nations, the latter contributing by far the larger portion. The first recorded production was in 1880, when the amount was reported as 120,947 short tons. By the time the Eleventh Census was taken this production had increased to 752,832 tons, or 50 per cent; in 1902 it had grown to 2,820,666 tons. Of the amount of coal produced during 1902, 2,587,100 tons were loaded at mines for shipment; 25,998 tons were sold to the local trade and used by employees; 96,017 tons were used at the mines for steam and heat, and 111,551 tons were made into coke. The average price per ton received for coal was $1.51, as compared with $1.76 in 1889.

Indiana.—The coal fields of Indiana underlie the counties in the southwestern portion of the state and form a portion of the large Central coal field. There are said to be at least 8 workable coal beds, although as a usual thing not more than 3 of these are found in workable thickness at any one locality, and generally there is only one bed that can be worked from one shaft.

The eastern part of the coal fields of Indiana is noted for its production of what is known as Indiana, or "Brazil" block coal, which is in favor as a domestic and steam fuel. This coal receives its name from the almost perfect rectangular blocks into which the coal naturally breaks because of the pronounced cleavage planes intersecting each other at right angles. Some cannel and some semiblock coal are also produced in this state.

The production in 1902 amounted to 9,446,424 short tons, valued at $10,399,660. In 1889 the production was reported by the Eleventh Census at 2,845,057 short tons, valued at $2,887,852, and the Tenth Census in 1880 reported the production of that year at 1,454,327 short tons, valued at $2,150,258.

Table 25 shows by counties the total production of Indiana in 1902, the disposition of the same, and the total amount received for the coal sold, together with the average price per ton at the mines.

TABLE 25.—*Coal production of Indiana, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	8,599,144	586,899	259,681	700	9,446,424	$10,399,660	$1.10
Clay	1,241,950	28,850	44,246	....	1,315,046	1,799,839	1.37
Daviess	178,368	33,193	5,765	....	217,326	272,995	1.26
Dubois	....	9,991	103	....	10,094	11,951	1.48
Fountain	13,781	2,820	498	....	17,099	19,891	1.16
Gibson	87,761	13,307	4,400	....	105,468	105,069	1.00
Greene	1,546,594	84,568	32,623	....	1,663,785	1,745,601	1.05
Knox	79,635	33,873	5,717	....	119,225	134,970	1.13
Martin	14,370	3,107	180	....	17,657	29,987	1.70
Parke	1,090,162	21,693	43,602	....	1,155,457	1,481,315	1.28
Perry	10,425	10,792	360	....	21,577	27,914	1.29
Pike	466,130	34,741	9,146	....	510,017	532,551	1.04
Spencer	1,340	14,884	50	....	16,274	19,886	1.22
Sullivan	1,177,158	50,579	41,208	....	1,268,945	1,298,903	1.02
Vanderburg	97,763	112,889	7,460	....	218,112	250,396	1.15
Vermillion	698,719	3,343	16,040	....	718,102	652,597	0.91
Vigo	1,551,849	59,808	40,441	700	1,652,798	1,570,796	0.95
Warren	....	3,280	100	....	3,380	7,460	2.21
Warrick	343,139	65,181	7,742	....	416,062	434,547	1.04

The production of Indiana in 1902 included 1,101,544 short tons of block and semiblock coal, 1,000 tons of splint coal, and 30,000 tons of cannel coal. The remainder of the product was noncoking bituminous coal. The reported mining expenses incurred in the production of Indiana coal in 1902 were as follows: For salaries, $530,492; for wages, $7,396,425; for contract work, $26,603; miscellaneous expenses, $449,054; and for supplies and materials, $729,104. The dividends paid by incorporated companies amounted during the year to $161,336, the interest paid on bonds to $16,720, and assessments were levied to the amount of $83,700. The statistics of mining operations during 1902, in counties having a production of 200,000 tons and over, are as follows:

TABLE 26.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	339	283	637	$530,492	10,789	$7,396,425	$26,603	101	$449,054	$729,104	9,446,424	$10,399,660
Clay	39	21	108	90,046	1,900	1,306,807	2,622	12	91,982	96,245	1,315,046	1,799,839
Daviess	22	19	22	13,365	308	190,313	1,000	10	11,535	9,885	217,326	272,995
Greene	37	32	100	87,412	1,559	1,225,254	800	5	59,677	158,990	1,663,785	1,745,601
Parke	23	15	67	68,847	1,473	972,682	....	....	57,107	109,760	1,155,457	1,481,315
Pike	50	37	40	30,328	698	794,705	....	....	16,042	32,733	510,017	532,551
Sullivan	21	23	86	67,516	1,101	906,129	7,601	24	65,452	101,370	1,268,945	1,298,903
Vanderburg	6	6	28	21,573	294	178,842	....	....	11,606	12,701	218,112	250,396
Vermillion	8	7	25	22,192	763	540,325	1,365	10	22,798	18,158	718,102	652,597
Vigo	35	23	38	81,965	1,781	1,183,537	12,340	32	81,998	103,507	1,652,798	1,570,796
Warrick	12	11	21	17,640	367	240,130	....	....	17,051	21,476	416,062	434,547
Other counties[1]	75	69	39	25,406	409	247,701	875	8	14,026	31,157	310,774	360,120

[1] Includes Dubois, Fountain, Gibson, Knox, Martin, Perry, Spencer, and Warren.

Iowa.—The northern part of the Western coal field is in the southwestern portion of Iowa, about two-fifths of the state being underlaid by coal, which is mined in 24 counties; 4 of these, namely, Appanoose, Mahaska, Monroe, and Polk, produced about two-thirds of the total. The total coal producing area is estimated at 20,000 square miles. The product is of the dry noncoking variety of bituminous coal, with small amounts of block and cannel. With the exception of the block and cannel coals, the product is generally better adapted for steam raising than for any other industrial purpose. Some attempts have been made to coke the Iowa coals on a commercial basis, but owing to the competition of the higher grade product from other sources the attempts were not profitable and have been abandoned, and no coke has been made in Iowa since 1891, in which year 157 tons were produced. The coals are usually high in both sulphur and ash.

Coal mining in Iowa began at quite an early date, an output of 360 tons having been reported as early as 1840. The Eighth Census showed that the production for 1860 was 41,920 short tons. By 1870 it had grown to 263,487 tons, and in 1880 to 1,461,116 tons. The census of 1889 showed a production of 4,095,358 tons. By 1902 it amounted to 5,904,766 tons. In amount of production Iowa ranked ninth among the coal producing states; in the states west of the Mississippi river it stood second, Colorado being first.

The following table shows the production, distribution, and price of coal in Iowa by counties during 1902:

TABLE 27.—*Coal production of Iowa, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	5,099,558	678,710	126,498	5,904,766	$8,660,287	$1.47
Adams	....	19,707	44	19,751	46,693	2.36
Appanoose	848,553	35,187	16,597	900,337	1,530,002	1.70
Boone	229,062	20,790	1,472	251,324	480,624	1.91
Dallas	7,831	8,609	2,405	18,845	37,557	1.99
Davis	....	3,953	....	3,953	6,573	1.66
Greene	....	11,501	72	11,573	24,408	2.11
Jasper	181,630	45,805	6,005	233,440	331,283	1.42
Jefferson	6,300	4,110	200	10,610	19,651	1.85
Keokuk	91,976	10,779	3,348	106,103	143,169	1.35
Mahaska	649,032	59,470	15,065	723,567	1,031,554	1.43
Marion	275,287	31,752	8,386	315,425	347,207	1.10
Monroe	1,355,464	23,637	27,804	1,406,905	1,806,365	1.28
Page	....	10,022	48	10,070	25,277	2.51
Polk	763,345	231,975	28,540	1,023,860	1,541,406	1.51
Scott	....	10,176	182	10,358	19,858	1.92
Taylor	8,357	5,785	65	14,207	32,186	2.27
Van Buren	10,836	3,967	13	14,816	24,499	1.65
Wapello	257,937	77,409	5,416	340,762	460,341	1.35
Warren	10,227	9,900	....	20,127	38,888	1.93
Wayne	56,782	7,794	798	65,374	128,135	1.96
Webster	109,735	36,030	3,850	149,615	265,308	1.77
Guthrie, Lucas, and Story	227,484	10,081	13,179	250,744	313,317	1.25

The detailed statistics for the mining of coal in Iowa during 1902, in counties having a production of 200,000 tons or over, are shown in the following table:

TABLE 28.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	346	299	512	$436,828	9,439	$6,251,732	$48,046	240	$341,191	$841,506	5,904,766	$8,660,287
Appanoose	76	59	117	95,930	1,785	1,153,056	8,002	18	69,260	85,198	900,237	1,530,002
Boone	10	9	22	22,775	496	307,256	....	....	20,228	21,176	254,324	490,624
Jasper	16	15	11	9,950	286	210,790	820	4	13,209	42,407	233,440	331,283
Mahaska	62	42	59	49,350	1,048	719,324	13,690	31	34,214	143,146	723,567	1,031,554
Marion	24	24	23	15,636	404	241,167	10,128	62	9,042	42,267	315,425	347,207
Monroe	13	9	70	62,542	2,196	1,515,986	1,800	21	42,760	152,609	1,400,905	1,806,305
Polk	21	21	99	90,841	1,382	986,130	7,329	49	99,054	169,356	1,023,860	1,541,406
Wapello	17	14	34	31,285	548	307,600	5,097	37	10,695	38,837	340,762	460,331
Other counties[1]	107	106	77	58,519	1,294	810,533	1,180	18	42,729	148,510	706,146	1,125,515

[1] Includes Adams, Dallas, Davis, Greene, Guthrie, Jefferson, Keokuk, Lucas, Page, Scott, Story, Taylor, Van Buren, Warren, Wayne, and Webster. (Lucas county had a production exceeding 200,000 tons, but is not shown separately in order to avoid disclosing the operations of individual operators.)

Kansas.—The Kansas coal areas lie entirely in the eastern portion of the state, the western boundary of the Western coal field traversing Kansas in an almost due north and south line from Marshall county, adjoining the state line of Nebraska on the north, to Chautauqua county, adjoining Indian Territory on the south. There are some isolated deposits in the central portion of the state, but the beds are thin and the coal is of inferior quality and not at present mined on a commercial scale. The larger portion of the production is obtained from the counties of Cherokee and Crawford, in the southeastern corner of the state, these 2 counties contributing about 90 per cent of the entire output. These 2 counties are underlaid by the Lower Coal Measures, which form the eastern portion of the Western field, and which contain the most important and productive beds.

The production of the state is used principally for domestic and railroad consumption. A small quantity of coke is made at irregular intervals in Cherokee county, the coke being utilized by the zinc smelters in the immediate vicinity. The larger portion of the product is, like that of Iowa, of the dry, noncoking variety of bituminous coal.

Coal mining as an industry in Kansas, so far as records are concerned, began in 1869, when, according to the report of the United States Geological Survey, 36,891 tons were produced. In 1880, at the taking of the Tenth Census, the production of coal in Kansas amounted to 771,442 short tons. In 1889 it had increased to 2,221,043 tons. In 1902 it amounted to 5,266,065 tons. The development of the coal mining industry in Kansas, as in the adjoining states, Iowa and Missouri, has kept pace with the increase of population and the establishment of manufacturing industries. The markets are restricted to a comparatively limited area, and the coal is not shipped to points far distant from the mines. Any increase in production from this part of the Western coal field may be accepted as indicative in large part of the development and growth of population and manufactures within the 3 states. The statistics of production for 1902 are as follows:

TABLE 29.—*Coal production of Kansas, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	4,941,236	227,826	95,237	1,766	5,266,065	$6,862,787	$1.30
Cherokee	1,792,092	26,094	29,944	1,766	1,849,896	2,305,112	1.25
Cloud	....	7,624	....	....	7,624	19,909	2.61
Crawford	2,765,898	67,895	47,481	....	2,881,274	3,489,728	1.21
Franklin	1,735	3,264	....	....	4,999	12,117	2.42
Leavenworth	195,023	80,372	16,286	....	291,681	555,919	1.91
Linn	24,060	5,480	300	....	29,780	41,770	1.40
Osage	161,982	30,573	226	....	192,781	416,746	2.16
Other counties[1]	446	6,684	1,000	....	8,130	21,636	2.66

[1] Includes Atchison, Bourbon, Coffey, Jewell, Labette, and Republic.

There are only 3 counties in the state the production of which in 1902 exceeded 200,000 tons. These counties were Cherokee, Crawford, and Leavenworth. The statistics of salaries, wages, and other expenses in these counties, as compared with the production and value, are shown in Table 30.

TABLE 30.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	175	132	367	$345,162	7,017	$4,719,595	$3,644	106	$418,921	$596,501	5,266,065	$6,962,787
Cherokee	48	34	108	97,451	2,290	1,591,719	1,589	7	122,020	206,930	1,849,896	2,395,112
Crawford	50	28	180	187,503	3,604	2,434,385	392	5	244,718	320,805	2,881,274	3,499,528
Leavenworth	5	3	42	39,250	449	309,310			28,867	44,090	291,681	555,969
Other counties [1]	72	67	37	20,958	674	384,181	1,663	94	23,286	24,676	243,214	512,178

[1] Includes Atchison, Bourbon, Cloud, Coffey, Franklin, Jewell, Labette, Linn, Osage, and Republic.

Kentucky.—Kentucky is the only one of the United States whose coal product is drawn from more than one of the great coal fields. The coal producing counties of the eastern portion of the state are included in the coal measures of the Appalachian system, while the southern extremity of the Western coal field is found in the western counties. More than half of the entire production is obtained from the counties in the western part of the state. The Appalachian system covers the entire eastern portion of the state to an extent of 10,300 square miles, and the portion of the western part of the state underlaid by coal is estimated to contain 5,800 square miles, making a total area of 16,100 square miles.

The principal producing counties in the eastern portion of the state are: Bell, Boyd, Breathitt, Carter, Greenup, Johnson, Knox, Laurel, Lawrence, Lee, Pulaski, Rockcastle, and Whitley.

Those in the western portion are: Butler, Christian, Daviess, Hancock, Henderson, Hopkins, McLean, Muhlenberg, Ohio, Union, and Webster.

The coal found in the eastern portion of the state is usually the semibituminous variety, free burning and noncoking, but the different seams comprise all varieties of bituminous coal, from bituminous shale to cannel coal. Some of the coals in the eastern portion of the state have a high reputation as steam producers, particularly that kind known as the Jellico coal, which is mined in Whitley county, Kentucky, and in Campbell county, Tennessee. A considerable quantity of coke is made from coal mined in Hopkins county in the Western coal field, and in Bell county in the southern portion of the Eastern district. The state possesses some of the finest beds of cannel coal known to exist in the United States. It is mined both in the eastern and western districts, and is distributed widely throughout the eastern cities as a domestic grate coal. This cannel coal commands a much higher price at the mine than the ordinary bituminous and semibituminous coal mined in the state.

The production of cannel coal in Kentucky in 1902 amounted to 65,317 short tons, the largest output of this variety of coal obtained in any of the producing states. The census of 1840 credits Kentucky with a production of 23,527 short tons, and at the census of 1860, 285,760 tons were reported. The census of 1870 shows that Kentucky produced in that year 168,651 short tons, and at the census of 1880 the production was 946,288 short tons; in 1889 the Eleventh Census reported a production of 2,399,755 tons. In 1902 the output amounted to 6,766,984 tons. The production has increased steadily since 1893, the output in 1902 being more than double that in the former year.

Kentucky ranked eighth in importance among the coal producing states in 1902, and third among those south of the Ohio and Potomac rivers.

The production by counties, with the distribution of the product for consumption, is shown for Kentucky in Table 31.

TABLE 31.—COAL PRODUCTION OF KENTUCKY, BY COUNTIES: 1902.

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	6,141,886	333,584	132,812	158,702	6,766,984	$6,666,967	$0.99
Bell	352,942	5,369	7,210	96,247	461,768	478,801	1.04
Boyd	241,127	844	50		242,021	193,494	0.80
Breathitt	22,919	954			23,873	31,487	1.32
Butler	9,600	3,268			12,868	15,915	1.24
Carter	268,056	8,350	4,995		281,401	285,271	1.01
Clay		7,093			7,093	6,007	0.85
Daviess	9,973	10,195	350		20,518	19,558	0.95
Floyd		2,728			2,728	2,872	1.05
Hancock	10,297	6,640	900		17,837	17,252	0.97
Harlan		1,628			1,628	1,701	1.04
Henderson	113,689	41,459	3,323		158,471	149,895	0.95
Hopkins and Christian	1,499,872	38,249	44,539	59,777	1,642,437	1,340,020	0.82
Johnson	67,000	4,537	[redacted]		72,137	85,296	1.19
Knott		2,790			2,790	2,706	0.97
Knox	466,357	4,150	11,312		481,819	471,754	0.98
Laurel	353,433	44,478	5,086		402,997	394,883	0.98
Lawrence	37,527	12,539	7,321		57,387	55,069	0.96
Lee	36,275	376			36,651	41,062	1.12
Leslie		4,699			4,699	6,617	1.41
Letcher		1,941			1,941	2,385	1.23
McLean	47,788	6,620	160		54,568	50,108	0.91
Magoffin		6,663			6,663	8,021	1.20
Morgan	49,410	3,926	1,000		54,336	113,746	2.09
Muhlenberg	680,729	9,637	10,333		700,700	621,841	0.89
Ohio	513,583	17,943	9,700		541,226	489,518	0.90
Owsley		13,494			13,494	18,035	1.34
Pike		5,092			5,092	5,219	1.02
Pulaski	152,307	3,370	3,820		159,497	204,537	1.28
Union	279,241	23,909	9,958	2,678	315,786	338,794	1.07
Webster	257,835	13,137	7,070		278,042	238,786	0.86
Whitley	668,096	15,325	4,410		687,831	952,608	1.38
Other counties[1]	3,829	12,181	675		16,685	23,719	1.44

[1] Includes Crittenden, Edmonson, Elliott, Grayson, Greenup, Jackson, Madison, Martin, Menifee, Perry, Rockcastle, Trigg, Warren, Wayne, and Wolfe.

Hopkins county is the most important producer, having an output in 1902 of 1,555,084 short tons. The largest mines in the state are located in this county.

Table 32 shows the statistics relating to coal mining in Kentucky for such counties as produced 200,000 tons or over during 1902. It should be stated here that the statistics do not include a large number (from 1,000 to 1,200) of small country banks producing anywhere from 5 to 50 tons of coal a year, reports from which could not be obtained by correspondence. The quantity and value of the product were not sufficient to warrant the expense necessary to secure the reports by personal visits of special agents.

TABLE 32.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	523	503	593	$476,508	9,077	$4,522,207	$10,668	73	$285,792	$743,313	6,766,984	$6,666,967
Bell	11	11	45	41,500	644	342,547			35,542	29,432	461,768	478,801
Boyd	6	4	13	9,988	294	167,418			9,218	8,850	242,021	193,494
Carter	25	24	22	14,960	488	210,720			14,341	19,355	281,401	285,271
Hopkins	17	11	53	65,490	1,599	769,044	2,300	12	47,850	334,559	1,555,084	1,252,492
Knox	12	11	64	44,966	630	325,492			17,739	37,946	481,819	471,754
Laurel	13	13	35	27,340	687	296,657			11,784	15,925	402,997	394,883
Muhlenberg	16	15	50	44,984	863	448,581	500	8	25,145	41,036	700,700	621,841
Ohio	24	21	74	49,084	677	350,216	150	2	27,418	70,190	541,226	489,518
Union	11	11	23	16,962	352	202,409			5,114	17,645	315,786	338,794
Webster	12	11	23	14,480	322	150,088	500	3	12,693	25,834	278,042	238,786
Whitley	28	26	84	74,251	1,106	691,691	5,106	25	51,990	54,522	687,831	952,608
Other counties[1]	348	345	117	72,435	1,465	677,444	2,112	23	27,018	88,129	818,309	948,725

[1] Includes Breathitt, Butler, Christian, Clay, Crittenden, Daviess, Edmonson, Elliott, Floyd, Grayson, Greenup, Hancock, Harlan, Henderson, Jackson, Johnson, Knott, Lawrence, Lee, Leslie, Letcher, McLean, Madison, Magoffin, Martin, Menifee, Morgan, Owsley, Perry, Pike, Pulaski, Rockcastle, Trigg, Warren, Wayne, and Wolfe.

Maryland.—The coal fields of Maryland are a part of an extensive basin extending from Somerset county, in Pennsylvania, through Allegany and Garrett counties, in the western part of Maryland, to Tucker county, in West Virginia. They are separated from the main field of the Appalachian system by the Great Savage mountains, and are nearer to tidewater than any of the important coal producing fields of the United States.

In this region there occurs what is known as the Big Vein of Maryland and West Virginia, the production from which has a high and thoroughly established reputation for quality. As a blacksmithing coal it stands without a competitor in the United States, to almost all portions of which it is shipped for this purpose. Some Maryland coal is also sent abroad for blacksmithing and forge purposes. This coal is also said to make good coke, but on account of the high price obtained for the raw coal it is found more profitable to sell it in that condition than to make it into coke. Practically the entire product is sold as run-of-mine, and little screening is done in preparing the coal for market.

The first discovery of coal in Maryland was made in the vicinity of Frostburg in 1804, and coal has been extracted from this section almost continuously since that date. The exploitation on a commercial basis may be said to have begun with the construction of the Baltimore and Ohio Railroad, which reached the coal fields in 1842. According to the reports of the "Cumberland Coal Trade," which have been kept continuously since that date, shipments in 1842 amounted to 1,913 short tons, and adding an estimate of 10 per cent for local consumption, the production in that year would have been 2,104 tons. In 1850 the Chesapeake and Ohio Canal was completed to Cumberland, and from that date the production of the region continued to grow rapidly, although on account of the comparatively small productive area the increase in production has not kept pace with that of some of the other states having larger coal areas. It is thought that the maximum yearly production for Maryland has been nearly reached. The output in 1902 amounted to 5,271,609 short tons, valued at $5,579,869, as compared with 2,939,715 short tons, valued at $2,517,474, in 1889, and 2,228,917 short tons, valued at $2,585,537, in 1880. The product of 1902 was distributed as follows:

	Tons.
Loaded at mines for shipment	5,187,175
Sold to local trade and used by employees	48,631
Used at mines for steam and heat	35,803

The coal mining industry of Maryland in 1902 was considerably benefited through the strike in the anthracite coal fields in Pennsylvania. The average price per short ton was $1.06 in 1902, as compared with $0.99 in 1901. In 1889 the average price per short ton was $0.86. The bulk of the production was from Allegany county, only 2.7 per cent of the output in 1902 being from Garrett county.

Michigan.—All of what is known as the Northern coal field lies within the lower peninsula of the state of Michigan, between Lake Michigan and Lake Huron. It is estimated to contain an area of approximately 11,300 square miles. It is the only coal field known in the drainage basin of the Great Lakes and the St. Lawrence river. The coal is of an inferior quality, when compared with that of the Appalachian region, having a high percentage of both ash and sulphur. It is probably for this reason that the development of the region has been somewhat slow in comparison with that of other regions.

It is reported that the portion of the field near Jackson was producing coal as early as 1835, but it was not until 1868 that any estimate of the production was obtained. In that year the output amounted, it is stated, to 28,000 tons. The Census report of 1870 gave the production at 31,528 short tons. In 1880, according to the Tenth Census, the production was 100,800 short tons. In 1881 and 1882 there was a little increase, but for the next thirteen years, according to the reports of the United States Geological Survey, the production not only did not increase, but showed a declining tendency, which was due undoubtedly to the excessive production and consequent low prices of coal from the fields having a better quality or lower cost of production. At the Eleventh Census, for the year 1889, the output was only 67,431 tons. Since 1897, however, because of the higher prices of coal from other regions, and also because of the rapid industrial growth of the cities on Lake Erie and Lake Huron, the demand for, and the production of, Michigan coal have increased with notable rapidity. According to the report of the United States Geological Survey the production of coal in Michigan in 1901 was 1,241,241 short tons. A strike of the mine workers in 1902 reduced the production of the state to 964,718 short tons.

The distribution of this production, by counties, is shown in the following table:

TABLE 33.—*Coal production of Michigan, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	818,687	117,978	28,053	964,718	$1,653,192	$1.71
Bay	209,133	29,596	9,916	248,645	410,615	1.65
Eaton		7,961	99	8,060	18,890	2.34
Saginaw	604,904	50,100	15,300	670,304	1,141,409	1.70
Huron, Jackson, and Shiawassee	4,650	30,301	2,738	37,689	82,278	2.18

There were only two counties the production of which exceeded 200,000 tons during the year. The following table shows the statistics of coal mining for these counties for 1902:

TABLE 34.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries	Average number	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	31	30	99	$87,780	1,445	$1,075,805	$7,500	13	$106,414	$82,448	964,718	$1,653,192
Bay	9	9	35	23,968	338	257,176	2,500	7	30,660	31,300	248,645	410,615
Saginaw	11	10	55	56,742	992	751,536	5,000	6	71,323	48,488	670,304	1,141,409
Other counties[1]	11	11	9	7,070	115	67,093	....	....	4,431	2,660	45,769	101,168

[1] Includes Eaton, Huron, Jackson, and Shiawassee.

Missouri.—The coal areas of Missouri belong to the Western coal field and underlie about one-half of the state, the dividing line being one roughly drawn from the northeastern to the southwestern corners of the state. As they belong to the same field as those of Iowa and Kansas, what has been said in regard to the nature of the coals of those states applies also to the coals of Missouri.

Practically all of the coal produced in the state is consumed within its borders, and, other things being equal, any increased production may be considered as probably indicating a growth in local population or industry. The state is almost entirely surrounded by other coal producing states, and the large cities of the eastern portion obtain their principal supply of fuel from Illinois rather than from the mines of Missouri.

As far as any historical records go, the development of the coal mines of Missouri began in the same year as coal mining in Iowa. This was in 1840, when an output of 9,971 tons was obtained. At the census of 1870 the product was reported as 621,930 tons and at the census of 1880, as 844,304 tons. The Eleventh Census shows the production in 1889 to have been 2,557,823 tons, while in 1902 it amounted to 3,890,154 tons. Owing to the natural restrictions upon the marketing of Missouri coal, its increase in production has not kept pace with that of the neighboring states.

In Table 35 is shown the production of coal in 1902, by counties, with the distribution of the product for consumption.

TABLE 35.—*Coal production of Missouri, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	3,503,993	318,992	67,169	3,890,154	$5,374,642	$1.38
Adair	312,171	14,896	4,092	331,159	437,631	1.32
Audrain	14,211	11,068	929	26,208	43,253	1.65
Barton	186,215	10,638	3,493	200,346	240,374	1.20
Bates	319,361	28,376	6,970	354,707	397,928	1.12
Boone	11,190	15,636	180	27,006	37,169	1.38
Callaway	900	25,106	116	26,122	45,066	1.72
Carroll	....	2,376	....	2,376	5,065	2.13
Chariton	....	2,116	....	2,116	4,204	1.99
Henry	64,853	32,798	1,180	98,831	161,493	1.63
Howard	....	2,683	....	2,683	5,195	1.94
Johnson	....	5,530	10	5,540	10,465	1.89
Lafayette	488,392	44,444	10,965	543,801	929,862	1.71
Linn	63,724	16,653	661	81,038	130,906	1.61
Macon	1,039,687	9,212	15,827	1,064,726	1,328,796	1.25
Monroe	....	2,101	....	2,101	3,849	1.83
Montgomery	1,226	2,558	317	4,101	9,052	2.21
Putnam	121,424	3,648	2,911	127,983	197,869	1.55
Ralls	18,252	1,100	20	19,372	27,068	1.40
Randolph	399,680	19,008	5,479	424,167	524,636	1.24
Ray	204,859	26,164	4,043	235,066	383,492	1.63
St. Clair	670	3,160	30	3,860	6,390	1.66
Schuyler	1,428	2,772	40	4,240	6,435	1.52
Vernon	204,412	8,433	5,494	218,339	266,369	1.22
Other counties[1]	51,268	28,216	4,412	83,896	171,605	2.05

[1] Includes Caldwell, Cedar, Cooper, Dade, Grundy, Jackson, Livingston, Morgan, Pettis, and Saline.

There were 33 counties in the state from which coal production was reported in 1902, although coal is found in as many as 39 counties. Of the 33 counties producing in 1902, there were 8 in which the output exceeded 200,000 tons.

The statistics for the industry are shown in the following table, the counties producing over 200,000 tons being given separately:

TABLE 36.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	384	345	420	$325,117	6,501	$3,927,159	$42,031	110	$250,078	$304,821	3,890,154	$5,374,642
Adair	17	12	69	40,110	513	345,000	22,744	(1)	18,892	23,789	331,159	437,631
Barton	22	18	41	37,546	261	168,649	....	....	51,518	31,569	200,346	240,374
Bates	32	32	21	16,811	490	340,695	9,702	40	21,800	20,699	354,707	397,928
Lafayette	54	52	67	45,400	1,127	657,471	2,601	16	18,050	34,111	543,801	929,862
Macon	19	9	69	89,002	1,469	899,903	....	....	60,201	93,003	1,064,726	1,328,796
Randolph	21	19	29	25,506	697	407,874	2,141	12	14,328	31,594	424,167	524,636
Ray	33	27	30	17,705	485	287,862	1,137	11	20,772	13,467	235,066	383,492
Vernon	16	13	16	7,838	242	177,408	40	2	15,307	12,712	218,339	266,369
Other counties[2]	170	163	78	45,229	1,217	642,286	3,666	29	29,150	43,867	517,843	865,554

[1] Not reported.

[2] Includes Audrain, Boone, Caldwell, Callaway, Carroll, Cedar, Chariton, Cooper, Dade, Grundy, Henry, Howard, Jackson, Johnson, Linn, Livingston, Monroe, Montgomery, Morgan, Pettis, Putnam, Ralls, St. Clair, Saline, and Schuyler.

Montana.—The coal areas of Montana are included in the Rocky Mountain fields. Most of the deposits are of the Cretaceous age and vary from lignite to bituminous, the lignites usually being in the plains region and the bituminous coals in the mountain ranges. The coal fields form a nearly continuous belt, and cross the state in a northwest-southeast direction. Little detailed investigation has been made and only a general idea can be formed as to the extent and value of these fields. The coal bearing areas are estimated to contain 32,000 square miles. Some of the coals possess excellent coking qualities, the coke being used in the smelters and refineries as far east as Omaha.

The first statement regarding the production of coal in Montana is that made by the Tenth Census, which shows that in 1880, 224 tons were produced. The active development of Montana's coal mines began in the latter part of the decade 1880 to 1890, and in 1889, according to the Eleventh Census, the production was 363,301 short tons, valued at $880,773, or an average of $2.42 per ton. In 1902 the production was 1,560,823 short tons, worth $2,443,447, or an average of $1.57 per ton. According to the reports of the United States Geological Survey the coal production of Montana reached the market limits in 1895, when it amounted to 1,504,193 short tons. Since that time the production has remained almost stationary, the maximum being attained in 1900, with a total of 1,661,775 short tons, and the minimum in 1901, when a total of 1,396,081 tons was produced.

The statistics of production in 1902, by counties, with the distribution of the product for consumption, are shown in the following table:

TABLE 37.—*Coal production of Montana, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	1,385,100	40,719	39,023	95,981	1,560,823	$2,443,447	$1.57
Carbon	576,472	9,270	19,212	....	604,954	791,222	1.31
Cascade	697,883	14,050	14,398	35,241	761,572	1,274,169	1.67
Chouteau	260	10,512	....	....	10,772	27,064	2.51
Fergus	600	4,600	....	....	5,200	16,900	3.25
Park	23,660	1,470	3,770	60,740	89,640	189,080	2.11
Other counties[1]	86,225	817	1,643	....	88,685	145,012	1.64

[1] Includes Deerlodge, Gallatin, Granite, and Meagher.

As shown in the above table there were only two counties, Carbon and Cascade, in which the production exceeded 200,000 short tons annually. These two counties together in 1902 produced 1,366,526 short tons out of a total of 1,560,823 short tons.

The statistics of the industry are given in the following table, the counties of Carbon and Cascade having a production of over 200,000 tons each, being shown separately:

TABLE 38.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	37	34	61	$50,674	1,587	$1,516,043	$1,000	13	$118,693	$233,930	1,560,823	$2,443,447
Carbon	3	3	10	15,170	552	534,761	1,000	13	16,420	79,235	604,954	791,222
Cascade	9	7	36	17,639	766	725,078	....	....	88,863	111,425	761,572	1,274,169
Other counties[1]	25	24	15	17,865	269	256,204	....	....	13,410	43,270	194,297	378,056

[1] Includes Chouteau, Deerlodge, Fergus, Gallatin, Granite, Meagher, and Park.

New Mexico.—The coal producing areas of New Mexico are found in somewhat widely distributed fields or basins having seemingly little connection with each other. The three most important areas are those in Colfax, Rio Arriba, and McKinley counties. The first-mentioned area is an extension southward of the Las Animas, or Trinidad, area in Colorado, and occupies the northwestern portion of Colfax county. The La Plata field of Colorado, which is found in the southwestern portion of that state, suddenly turns at its eastern extremity and extends in a narrow strip almost due south, through Rio Arriba county and into McKinley county. Owing to its distance from railroad communication, this area has not been extensively developed. The Gallup field, which occupies a long, narrow strip extending north and south in the western part of McKinley county and into San Juan county on the north and Valencia county on the south, is one of the most extensively developed areas in the territory. In addition to these there are the Los Cerrillos area, in Santa Fe county, and the Carthage area, in Socorro county, in both of which mining operations are carried on. These are the only fields which have been extensively developed, although there are some isolated fields of economic importance in the territory, where small amounts are mined for local consumption.

The coals of New Mexico, like those of Colorado, range from lignite to anthracite. The anthracite occurs in the Los Cerrillos field, which has been penetrated by volcanic intrusion in close proximity to the coal beds, with the result of altering the bituminous coal to an anthracite of good grade. This anthracite is sold as far north as Denver and as far west as San Francisco. In 1902 the production was 41,326 short tons. All of this anthracite occurs in the northern part of the field. Toward the south the coal passes into coking and semicoking varieties of bituminous coal, the transition being very gradual and almost imperceptible. Good coking coal was also produced in Colfax county, the principal operations being near Raton. There were 8 counties in the territory which produced coal in 1902. In only 2, Colfax and McKinley, did the product amount to as much as 200,000 short tons during the year. No report of coal production in New Mexico was made at the Tenth Census, the first record of operations being that for the United States Geological Survey in 1882, in which year an output of 157,092 short tons was obtained. The production reported at the Eleventh Census, for 1889, was 486,463 tons. In 1902 it was 41,326 short tons of anthracite and 1,007,437 short tons of bituminous, a total production of 1,048,763 short tons.

In the following table is shown the production in 1902, by counties, with the distribution of the product for consumption:

TABLE 39.—*Coal production of New Mexico, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	973,500	19,514	33,180	22,569	1,048,763	$1,500,230	$1.43
Colfax	304,221	10,902	8,731	22,519	346,373	392,244	1.13
McKinley	418,981	3,515	9,612	....	432,108	593,361	1.37
Rio Arriba	47,000	....	600	....	47,600	69,000	1.45
San Juan	100	1,600	....	....	1,700	2,175	1.28
Santa Fe	81,636	422	8,837	....	90,895	179,944	1.98
Other counties[1]	121,562	3,075	5,400	50	130,087	263,506	2.03

[1] Includes Lincoln, San Miguel, and Socorro.

The statistics for the industry are as follows, counties producing 200,000 tons or more being shown separately:

TABLE 40.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	30	25	68	$85,599	1,139	$1,027,460	$5,770	81	$63,990	$150,513	1,048,763	$1,500,230
Colfax	6	5	20	33,619	598	597,309	1,770	4	9,083	22,194	346,373	392,244
McKinley	7	5	21	24,614	176	108,064	4,000	77	25,615	69,649	432,108	593,361
Other counties[1]	17	15	27	27,366	365	322,087	....	....	29,292	58,670	270,282	514,625

[1] Includes Lincoln, Rio Arriba, San Juan, Sante Fe, San Miguel, and Socorro.

North Carolina.—The only productive coal field in North Carolina is a small area lying in the valley of the Deep river, just west of the point where it joins the Cape Fear river. The area from which coal may be produced is a narrow strip 30 miles in length. Another small area lying along the Dan river, near where it crosses the Virginia line, is known to contain some coal, but it has not been developed and is regarded as of little promise for the future. The only mine operated in the Deep river basin is the Cumnock, formerly known as the Egypt mine. It was opened in 1889, with a production during that year of 192 tons. Detailed statistics are not published separately, in order that the confidential nature of the reports to the Bureau of the Census may be maintained.

North Dakota.—Although the coal producing areas of North Dakota are included in the Rocky Mountain fields they are not within the mountainous areas. They lie in about the middle of the state, in the great plains region.

All of the coal produced in the state is lignite and disintegrates rapidly upon exposure. Under present conditions it can not be used satisfactorily in locomotives, but answers the need of the community for domestic fuel and for use under stationary boilers. Comparatively little labor is necessary to procure the coal, strip or surface mining being frequently practiced. The coal mine operators have endeavored to improve the quality of their product by briquetting, but so far these attempts have been unsuccessful, failure being due principally to the high cost of binding materials.

No production of coal was reported from North Dakota at the Tenth Census. In 1889 the output was 28,907 short tons. This was almost entirely mined and used by the ranchmen in the immediate vicinity of the openings. In 1902 the production amounted to 226,511 short tons. The state of North Dakota has endeavored to foster its lignite mining industry by compelling its use in all state offices and institutions.

The statistics of production and distribution, by counties, in 1902, are as follows:

TABLE 41.—*Coal production of North Dakota, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	182,008	35,639	8,870	226,517	$325,967	$1.44
Morton	13,542	4,575	200	18,317	23,078	1.26
Stark	29,706	5,300	......	35,006	38,025	1.09
Ward	68,417	22,519	2,850	93,786	171,122	1.82
Other counties[1]	70,343	3,245	5,820	79,408	93,742	1.18

[1] Includes Burleigh, Emmons, and McLean.

Ohio.—Ohio is one of the 9 states whose coal fields are included in the great Appalachian system. Every county in the eastern half of the state, with the exception of a comparatively narrow belt of 4 counties bordering on Lake Erie, is, or has been, wholly or in part, underlaid by coal. The entire area underlaid by coal in this state has been estimated at 12,000 square miles, distributed over 30 counties in the eastern and southeastern portions. There are no less than 16 workable beds contained in the coal measures of the state, but only 6 of the 16 are of importance. The other 10 are worked by small operators, producing coal for purely local trade. The important beds are known as No. 1, the Block or Sharon coal seam; No. 2, the Wellston; No. 5, the Lower Kittanning; No. 6, the Middle Kittanning; No. 7, the Upper Freeport; and No. 8, the Pittsburg. The coals in these different beds embrace all the varieties of bituminous—steam, gas, coking, and cannel.

The most important producing bed is the Middle Kittanning, or No. 6. In Athens, Hocking, and Perry counties this bed is known as the Hocking Valley seam, which in the 3 counties mentioned produces from 35 to 40 per cent of the total output of the state. It is an excellent steam coal, is popular for domestic use, and also stands high as a furnace fuel, for which purpose it is used in its raw state. The thickness of this seam varies from 12 inches, in Columbiana county, to 13 feet in the Hocking valley.

No. 7, or the Upper Freeport, is second in importance. It is considered as one of the best steam coals in the state, and is consumed chiefly by the railroads. The principal development of this bed is in Guernsey county, which, in 1902, was third in importance as a coal producer.

The Wellston, or No. 2, is also an important producer, the chief operations being in the vicinity of Jackson and Wellston, in Jackson county. It is a free, open burning, noncoking coal, used to a considerable extent in its raw state among the local blast furnaces. It also stands high in popularity as a domestic fuel.

The No. 1, or Block coal seam, produces a good steam and domestic coal, but its chief use is as a blast furnace fuel, for which purpose it is used raw. The furnaces which first substituted coal for charcoal used this coal. What is familiarly known as "Massillon" coal, in the northern part of the state, is mined from this bed.

No. 5, or the Lower Kittanning bed, is best known for its coking qualities, it being the only coal in the state from which a fair grade of coke can be made. Little coke is made from it, however, owing to the proximity and cheapness of higher grade coking coals in Pennsylvania and West Virginia. The coal from this bed finds its principal use as a steam fuel.

No. 8, or the Pittsburg seam, underlies the whole or parts of the counties of Jefferson, Harrison, Belmont, Guernsey, Athens, and Meigs, in the southeastern portion of the state. While not the most important coal bed in the state, it is looked upon as one of the chief future sources of supply, owing to the approaching depletion of some of the other beds.

In the following table is shown the production in 1902, by counties, with the distribution of the product for consumption:

TABLE 42.—*Coal production of Ohio, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	22,232,404	1,041,112	242,594	3,784	23,519,894	$26,953,789	$1.15
Athens	3,281,410	13,146	22,241	2,800	3,319,597	3,635,762	1.09
Belmont	1,763,658	219,302	14,996	......	1,997,956	2,069,498	1.04
Carroll	190,969	30,996	3,414	......	225,379	288,956	1.28
Columbiana	724,765	48,102	20,991	......	793,858	885,656	1.12
Coshocton	388,289	48,995	500	......	437,784	536,196	1.22
Gallia	16,962	4,508	......	......	21,470	24,650	1.15
Guernsey	2,615,805	9,802	30,003	......	2,655,610	2,440,906	0.92
Harrison	355,192	4,500	1,800	......	361,492	315,756	0.87
Hocking	2,584,424	19,312	37,405	......	2,641,141	2,893,974	1.10
Holmes	600	14,185	......	......	14,785	21,492	1.45
Jackson	2,344,492	37,237	30,780	......	2,412,509	3,432,741	1.42
Jefferson	1,694,538	101,553	15,776	984	1,812,851	1,905,820	1.05
Lawrence	165,060	18,309	......	......	183,369	240,857	1.31
Mahoning	72,415	52,234	3,098	......	127,747	178,517	1.40
Medina	76,399	9,333	4,986	......	90,718	161,729	1.78
Meigs	263,402	63,506	12,781	......	339,689	390,713	1.15
Morgan	86,821	......	......	......	86,821	127,135	1.46
Muskingum	190,542	34,871	......	......	225,413	252,621	1.12
Perry	2,664,968	68,470	10,559	......	2,743,997	2,913,599	1.06
Stark	998,599	68,620	13,210	......	1,080,429	1,946,667	1.80
Summit	51,400	12,332	3,710	......	67,442	107,417	1.59
Trumbull	6,100	5,490	440	......	12,030	27,335	2.27
Tuscarawas	1,421,827	144,659	12,078	50	1,578,610	1,654,120	1.05
Vinton	90,751	1,124	566	......	92,441	116,614	1.26
Wayne	74,824	2,056	1,510	......	78,390	140,153	1.79
Other counties[1]	108,192	8,469	1,805	......	118,466	244,925	2.07

[1] Includes Noble, Portage, Scioto, and Washington.

Coal mining in Ohio began during the first quarter of the nineteenth century, but the exact date of the first operations is not known. The first shipment of which there is a record was made from Summit county in 1828, but it is not known how much coal was in this shipment. In 1838 the entire coal production was reported as 119,952 short tons. In 1840 the production was 140,535 short tons; in 1860 it amounted to 1,133,596 tons, and in 1870 it was 2,830,559 tons. The Tenth Census reported an output of 6,008,595 short tons for the fiscal year ending June 30, 1880. The Eleventh Census, for the calendar year 1889, showed a production of 9,976,787 short tons, and in 1902 it reached the maximum record of 23,519,894 short tons. The value of the product in 1889 was $9,355,400, an average of $0.94 per short ton. In 1902 the product was valued at $26,953,789, or $1.15 per ton. It is not believed that the record made in 1902 will be greatly exceeded in the future, as much of the best coal land has been, or is rapidly becoming, exhausted.

As will be seen from the foregoing table, there were 29 counties producing coal in Ohio during 1902. Fifteen of these produced more than 200,000 tons each, thus contributing 22,626,215 tons of the total, or an average of over 1,500,000 tons each. The 14 other counties produced 893,679 short tons, or an average of about 63,800 tons each.

The total amount paid in wages at the Ohio coal mines in 1902 was $16,693,464; other expenses reported amounted to $4,972,023, making a total of $21,665,487. The statistics of the industry are shown in the following table:

TABLE 43.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	648	513	1,314	$1,222,966	25,963	$16,693,464	$46,818	290	$1,619,451	$2,082,788	23,519,894	$26,953,789
Athens	34	22	169	170,124	3,240	2,168,759	1,479	10	312,487	272,342	3,319,597	3,635,762
Belmont	52	45	108	126,762	2,050	1,403,291	195	3	63,173	146,812	1,997,956	2,069,488
Carroll	12	11	21	12,770	280	181,227	....	....	10,488	20,967	225,379	288,956
Columbiana	28	23	44	42,287	916	601,358	1,065	8	45,453	51,433	793,858	885,636
Coshocton	39	39	24	22,749	589	392,322	....	....	23,098	86,019	437,784	536,196
Guernsey	20	14	87	87,002	2,198	1,490,246	6,906	23	144,551	218,037	2,655,610	2,440,906
Harrison	5	4	13	19,915	279	186,419	5,000	6	5,695	23,397	361,192	315,756
Hocking	20	5	59	62,142	2,366	1,649,428	971	6	175,561	191,159	2,641,141	2,893,974
Jackson	74	58	189	187,229	3,514	2,021,308	3,528	48	130,192	259,567	2,412,509	3,432,741
Jefferson	41	29	61	57,310	2,184	1,284,417	75	1	96,402	267,035	1,812,801	1,905,820
Meigs	15	15	31	20,642	436	251,097	....	....	20,948	23,456	339,639	390,713
Muskingum	27	27	25	15,126	259	177,977	1,895	14	7,921	15,808	225,113	252,621
Perry	59	41	144	132,955	2,811	1,844,627	2,544	79	265,274	219,230	2,743,997	2,913,569
Stark	46	28	86	89,257	1,806	1,078,764	10,575	46	140,743	143,137	1,660,429	1,946,667
Tuscarawas	70	60	92	79,044	1,616	1,098,707	908	4	72,420	117,200	1,578,610	1,654,120
Other counties[1]	106	92	161	97,342	1,409	863,617	11,657	42	115,255	77,189	893,679	1,390,814

[1] Includes Gallia, Holmes, Lawrence, Mahoning, Medina, Morgan, Noble, Portage, Scioto, Summit, Trumbull, Vinton, Washington, and Wayne.

Oregon.—Oregon has only one productive coal field. This is known as the Coos Bay field, in Coos county. It is directly on the coast, giving water transportation for the production, most of which is sent to San Francisco, Cal. According to Prof. J. S. Newberry, coal was mined on Coos bay in 1855, but records of these earlier years are entirely wanting. In 1889 the production amounted to 64,359 tons; in 1902 it was 65,648 tons, showing that the industry has not developed much during the last thirteen years.

Pennsylvania.—The bituminous coal areas of Pennsylvania, which embrace nearly the entire western half of the state, form the northern extremity of the great Appalachian field. Every county in the state west of the Allegheny mountains contains coal beds of economic value, while several outlying basins east of the mountains are also extensively mined. The entire bituminous coal producing area of Pennsylvania is estimated to contain about 15,800 square miles.

In the northern portion of the state the deposits are found principally in detached basins scattered through the counties of Bradford, Cameron, Clinton, Crawford, Elk, Forest, Lycoming, Potter, Tioga, Venango, and Warren. To the south and southwest of these the coal bearing rocks cover all, or nearly all, of the counties of Allegheny, Armstrong, Beaver, Butler, Cambria, Clarion, Clearfield, Fayette, Greene, Indiana, Jefferson, Mercer, Somerset, Washington, and Westmoreland, and portions of Blair and Center counties. The Huntingdon, or Broad Top, basin lies east of the main coal fields, in Bedford and Huntingdon counties.

The counties of Allegheny, Fayette, Greene, Washington, and Westmoreland, in the southwestern corner of the state, contain the upper productive measures, in which is found the famous Pittsburg bed, probably the largest and most productive single coal seam in the world. It is from this bed that the celebrated Youghiogheny gas coal of the Pittsburg district, in Allegheny and Washington counties, is obtained. Farther to the east it produces the famous Connellsville coking coal of Fayette and Westmoreland counties. In Maryland it yields the well known Cumberland coal, while some of the best coals of Ohio and West Virginia are also mined from it. In fact, it may be said that in quality, as in quantity, the coal contained in the Pittsburg bed is equal, if not superior, to any bituminous coal in the world.

Among the other beds in the state are the Upper Freeport, Lower Freeport, Upper Kittanning, Lower Kittanning, Blossburg, Brookville, Sharon, Mercer, Sewickley, and a number of other less important ones, all of which are described in detail in the Twenty-Second

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In the production of coal Pennsylvania far exceeds any other state. The combined output of anthracite and bituminous coal in Pennsylvania, from the beginning of the industry until 1902, has each year exceeded 50 per cent of the total production of the United States, the single exception in 1902 having been due to the decrease in anthracite production caused by the long strike. The bituminous product of the state alone has for many years been from 35 to 40 per cent of the total bituminous coal output of the country. In 1902 Pennsylvania produced 98,574,367 short tons of bituminous coal out of a total of 260,216,844 short tons, the percentage for the state being 37.9. In 1889 Pennsylvania produced 36,174,089 tons, or 37.8 per cent of a total of 95,629,026 tons. At the census of 1880 the total bituminous output was 42,831,758 short tons, of which Pennsylvania produced 18,425,163 short tons, or 43 per cent.

The output of bituminous coal in the state of Pennsylvania during the fiscal year ending June 30, 1880, was, as stated above, 18,425,163 short tons and the value of this product was $18,567,129, or an average of $1.01 per ton. The total amount of wages paid during this year was $10,863,583. During the calendar year 1889, Pennsylvania produced a total of 36,174,089 short tons, or nearly double the output of the census year 1880. The value of this product at the mines was $27,953,315, or an average of $0.77 per short ton. The total amount paid in wages in 1889 was $20,738,647. In 1902 the total bituminous production of Pennsylvania was 98,574,367 short tons, or $2\frac{7}{10}$ times that of 1889, and $5\frac{1}{3}$ times that of 1880. The total value of the product in 1902 was $106,032,460, an average of $1.08 per ton, the higher value in 1902, as compared with that of the preceding censuses, being due principally to the demand created for bituminous coal by the shortage in the supply of anthracite. The total amount paid in wages in the bituminous coal mines of Pennsylvania in 1902 was $59,848,902. In 1880 the average wage cost per ton of coal produced was 59 cents; in 1889 it was 57 cents; and in 1902 it was 61 cents. In 1880 the wage cost was equal to 58.4 per cent of the average selling price per ton; in 1889 the wage cost was 74 per cent of the selling price; while in 1902, owing to the high values caused by the strike in the anthracite region, the wage cost was only 56.5 per cent of the selling value.

Of the 24 counties in Pennsylvania from which a production was reported in 1902, there were 2 counties, Fayette and Westmoreland, the output of which exceeded 18,000,000 short tons each. Two other counties, Allegheny and Cambria, each exceeded 10,000,000 tons; 4 others, Washington, Clearfield, Jefferson, and Somerset, each exceeded 5,000,000 tons; and 4 more, Armstrong, Center, Indiana, and Tioga, produced between 1,000,000 and 2,000,000 tons each. The 2 counties of Fayette and Westmoreland, together, produced nearly 5,000,000 tons more than the entire state of Illinois, which was, in 1902, the second state in the production of coal, and 50 per cent more than West Virginia, which ranked third among the coal producing states.

The statistics of production in Pennsylvania, by counties, in 1902, with the distribution of the product for consumption, are shown in the following table:

TABLE 44.—*Coal, bituminous, of Pennsylvania—production by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	72,938,204	1,429,568	1,541,454	22,665,141	98,574,367	$106,032,460	$1.08
Allegheny	11,146,343	447,835	162,160	163,231	11,919,569	12,339,715	1.04
Armstrong	1,727,498	37,833	27,848	....	1,793,179	1,799,815	1.00
Beaver	205,549	17,255	2,358	....	225,162	305,438	1.36
Bedford	638,928	5,822	8,692	143,806	797,248	1,051,677	1.32
Blair	192,828	1,125	3,440	140,811	338,204	373,437	1.10
Butler	427,592	21,647	4,927	....	454,166	551,069	1.21
Cambria	9,420,308	165,942	186,049	789,536	10,561,835	12,895,501	1.22
Center	997,006	2,159	1,433	....	1,000,598	1,002,407	1.00
Clarion	448,238	4,872	5,111	....	458,221	577,638	1.26
Clearfield	6,873,639	81,423	83,560	296,163	7,334,785	8,414,670	1.15
Elk	716,624	19,442	12,632	7,484	756,182	735,622	0.97
Fayette	6,568,460	251,521	335,853	11,832,222	18,988,056	18,930,437	1.00
Huntingdon	387,751	8,185	8,526	55,923	460,385	685,080	1.49
Indiana	1,447,320	3,813	17,449	186,699	1,655,281	1,848,822	1.12
Jefferson	4,825,820	17,737	60,793	1,179,344	6,083,694	5,168,321	0.85
Lawrence	190,190	17,706	4,549	...	212,445	264,546	1.25
Mercer	597,447	8,152	23,114	....	628,713	673,455	1.07
Somerset	5,722,287	32,430	106,331	50,278	5,911,326	7,563,413	1.28
Tioga	1,126,097	16,299	7,453	....	1,149,849	1,761,098	1.53
Washington	8,348,994	44,753	136,207	....	8,529,954	8,805,905	1.03
Westmoreland	10,426,183	221,817	343,867	7,819,644	18,811,511	19,626,499	1.04
Other counties[1]	502,002	1,500	600	....	504,102	627,205	1.24

[1] Includes Clinton, Greene, and Lycoming.

The census returns for 1902 show that 236 corporations were engaged in bituminous coal mining operations in Pennsylvania. Of these, 225 reported their capitalization, showing a total capital stock issue of 2,585,468 shares, the par value aggregating $180,338,033. The dividends paid during the year amounted to $8,978,084, while assessments were levied to the amount of $27,600.

The expenses reported for the mining of bituminous coal in Pennsylvania, exclusive of interest on bonds and the costs of the sales departments, were $78,869,528. The statistics for the industry, by counties, the production of which amounted to 200,000 tons or more, are shown in the following table:

TABLE 45.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC. Number.	SALARIED OFFICIALS, CLERKS, ETC. Salaries.	WAGE-EARNERS Average number.	WAGE-EARNERS Wages.	CONTRACT WORK Amount paid.	CONTRACT WORK Number of employees.	Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT Quantity (short tons).	PRODUCT Value.
Total	1,023	511	3,880	$1,142,497	92,095	$59,848,962	$474,670	985	$6,178,975	$8,221,175	98,574,367	$106,082,460
Allegheny	87	27	315	390,705	10,618	7,962,809	5,024	11	764,040	967,896	11,919,569	12,339,718
Armstrong	21	17	72	90,165	2,239	1,278,002	1,060	3	80,900	201,604	1,793,179	1,799,815
Beaver	7	7	19	19,512	264	171,385			19,446	19,406	225,162	306,438
Bedford	23	11	99	109,811	1,059	732,635			65,354	79,163	797,248	1,051,677
Blair	7	3	22	27,392	386	240,409	6,716	22	24,641	41,019	339,204	373,437
Butler	12	14	36	37,057	674	392,258	1,622	5	28,573	27,887	454,166	551,069
Cambria	136	76	439	548,505	10,902	6,898,398	351,635	634	961,433	1,015,180	10,564,835	12,896,601
Center	25	16	39	33,133	995	654,419	851	2	50,092	83,934	1,000,508	1,002,407
Clarion	28	26	35	23,654	492	312,411			25,077	38,390	458,221	577,698
Clearfield	103	79	333	326,842	7,148	4,735,232	4,942	27	707,579	480,433	7,334,785	8,414,670
Fayette	129	55	506	521,671	14,071	9,468,800	10,624	20	650,486	1,392,315	18,988,068	18,930,437
Huntingdon	16	11	22	27,826	508	395,537	11,000	27	19,744	45,503	460,485	685,680
Indiana	28	17	76	90,003	1,505	1,069,067	100	3	75,695	154,133	1,655,281	1,848,822
Jefferson	31	10	98	90,393	6,314	3,751,144	21,171	42	554,254	518,100	6,083,494	5,168,321
Lawrence	8	7	28	22,212	268	195,474			15,755	15,714	212,445	264,546
Mercer	9	9	36	30,950	766	427,909	689	2	27,887	60,337	628,713	673,455
Somerset	65	42	216	212,580	6,103	3,469,264	579	3	744,728	543,477	5,911,326	7,598,413
Tioga	24	17	57	49,698	1,668	1,212,915	65	4	87,129	80,329	1,149,849	1,761,098
Washington	53	18	673	841,779	6,978	5,028,521			565,340	833,942	8,529,954	8,806,995
Westmoreland	133	55	670	673,996	17,210	10,618,061	57,010	177	843,729	1,591,862	18,811,611	19,626,499
Other counties[1]	11	7	39	34,893	1,647	942,252			68,962	93,902	1,290,284	1,362,827

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[1] Includes Clinton, Elk, Greene, and Lycoming. (Clinton and Elk counties each had a production exceeding 200,000 tons, but are not shown separately in order to avoid disclosing the operations of individual operators.)

Tennessee.—The great Appalachian coal fields cross the eastern central portion of Tennessee from northeast to southwest, the northern limit extending from Cumberland Gap, in Claiborne county, on the east, to Isham, in Scott county, on the west, a distance of about 45 miles. The coal bearing area narrows considerably toward the south, until near the center of the state, where it again widens out and is divided into two separate parallel basins. Farther south, in Alabama, it broadens still more, and covers nearly 50 per cent of the northern half of that state.

The coal fields of Tennessee are divided into two principal districts, the Jellico, in the northern half, and the Chattanooga, in the southern portion, the geographic division being made by the Emery river, a branch of the Tennessee river, which crosses the field from west to east through the southern portion of Morgan county. The Jellico district is subdivided into three distinct basins, the Jellico and the Middlesboro basins on the north, both of which extend into Kentucky, and the Wartburg basin, in the southern portion of the district. The Chattanooga district is divided into two long parallel basins referred to above, the one to the east being known as the Walden, and the one to the west as the Sewanee.

The Middlesboro basin, the northeastern extremity of the field in Tennessee, embraces portions of Campbell and Claiborne counties in Tennessee, and Bell county in Kentucky. It is a long, narrow syncline, extending in a northeast-southwest direction, and separated from the Jellico basin on the northwest by an unproductive area known as the Pineville anticline. The basin contains several coal beds of workable thickness, but only one, known locally as the Bryson bed, is mined at the present time.

The Jellico basin forms the western part of the coal field in northern Tennessee, and embraces portions of Scott and Campbell counties, in that state, and portions of Whitley and Knox counties, in Kentucky. The coal bearing formations in this basin are thinner than those in the Middlesboro basin, thinning out rapidly toward the northwest. The number and thickness of the coal beds also decrease in this portion. The principal development has been in the eastern part of the basin, along the line of the Southern Railway, where what is known as the Jellico bed is extensively worked. The coal from this bed is well known as a high-grade steam coal.

The Wartburg basin, in the southern portion of the Jellico district, underlies portions of Morgan, Anderson, and Scott counties. The principal developments have been along the eastern border, Oliver Springs, Briceville, and Coal Creek being the chief mining centers.

In the Chattanooga district the Walden basin, on the east, extends through portions of Roane, Rhea, Hamilton, and Marion counties, in a long, narrow belt running from northeast to southwest. The developments have been principally on the eastern border, along the line of the Cincinnati Southern Railway.

The Sewanee basin lies west of the Sequatchie valley, which separates it from the Walden basin. A large portion of the workable coal in this basin is found in what is known as the Sewanee bed, which, next to the Pittsburg bed of Pennsylvania, is probably the most regular and persistent in the United States. The Sewanee bed extends to the northern part of the state and into Kentucky, where, however, it is at greater depth and is not worked at present.

As in the case of the neighboring states of Kentucky and Alabama, the earliest official record of coal production in Tennessee was that for the census year 1860, when 165,300 tons were reported, although it is known that some coal was mined in all of these states prior to and during the Civil War. The census of 1870 reported the coal production of Tennessee as 149,428 short tons. The Tenth Census, covering the fiscal year ending June 30, 1880, reported the production of the state at 495,131 short tons, valued at $629,724, an average of $1.27 per ton. The Eleventh Census showed the total production of the state to be 1,925,689 short tons, valued at $2,338,309, an average of $1.21 per ton. The increase in production from the Tenth to the Eleventh Census was 289 per cent, and the value of the product increased 271 per cent during the same period. In 1902 the production of Tennessee amounted to 4,382,968 short tons, valued at $5,399,721, an average of $1.23 per ton.

The statistics of production during 1902, by counties, with the distribution of the product for consumption, are shown in Table 46.

TABLE 46.—*Coal production of Tennessee, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	3,417,409	88,369	63,283	813,907	4,382,968	$5,399,721	$1.23
Anderson	751,687	3,201	4,388	....	759,276	892,437	1.18
Campbell	488,429	27,913	17,823	120,000	654,165	978,575	1.50
Claiborne	694,997	15,710	4,900	33,168	748,765	815,295	1.09
Cumberland	107,450	650	1,492	....	109,592	105,271	0.96
Grundy	264,093	622	2,658	65,177	332,550	404,855	1.22
Marion	221,116	13,858	714	76,758	312,446	456,436	1.46
Morgan	357,940	1,408	6,696	103,598	469,642	518,374	1.10
Rhea	56,714	7,461	3,399	172,103	239,697	282,838	1.18
Scott	71,480	6,496	5,640	11,918	98,529	143,538	1.46
Other counties[1]	400,483	11,050	15,598	231,190	658,316	802,112	1.22

[1] Includes Bledsoe, Franklin, Hamilton, Overton, Roane, Sequatchie, and White.

Of the 16 coal producing counties in the state of Tennessee, there were 7 the output of which in 1902 exceeded 200,000 tons each. The statistics of the industry during 1902 are shown in the following table, the 7 counties being given separately:

TABLE 47.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	84	73	418	$381,939	6,220	$3,213,552	$14,094	71	$432,029	$390,561	4,382,968	$5,399,721
Anderson	13	8	58	55,000	1,091	585,796	9,247	37	109,119	71,238	759,276	892,437
Campbell	15	13	77	78,482	943	577,738	4,450	31	49,310	58,756	654,165	978,575
Claiborne	8	8	64	52,920	706	424,852	....	....	93,250	55,090	748,765	815,295
Grundy	4	3	21	17,129	495	254,828	....	....	30,871	28,346	332,550	404,855
Marion	6	5	42	34,745	653	303,544	....	....	45,611	44,909	312,446	456,436
Morgan	12	12	43	31,090	395	171,167	....	....	24,548	26,657	469,642	518,374
Rhea	6	4	21	14,317	416	190,625	....	....	25,623	24,476	239,697	282,838
Other counties[1]	20	20	102	97,656	1,521	742,983	397	3	53,689	78,009	866,427	1,050,921

[1] Includes Bledsoe, Cumberland, Franklin, Hamilton, Overton, Roane, Scott, Sequatchie, and White.

Texas.—The coal areas of Texas are included in the Western coal field, which finds its true southern limit in the central part of the state. The Texas areas, however, are separated from the main body of the Western field by the Arbuckle mountains, in the Chickasaw and Choctaw nations of Indian Territory.

Extensive beds of lignite are found underlying the greater part of the prairie region from the northeastern corner of the state to the Rio Grande, and an isolated basin of bituminous coal occurs in the southwestern portion of the state, at Eagle Pass. The principal bituminous mines are located along the line of the Texas and Pacific Railway at Weatherford, in Parker county; at Thurber, in Erath county; and at Bridgeport, in Wise county. Lignite coal is produced in considerable quantities at Rockdale, in Milam county, and at Calvert, in Robertson county. A considerable amount of bituminous coal is also produced at Eagle Pass, in Maverick county, and at Santo Tomas, near Laredo, in Webb county.

No report of coal mining in Texas was made at the Tenth Census. The Eleventh Census reported a total production for 1889 of 128,216 short tons, having a total value of $340,620, or an average of $2.66 per ton. The total amount paid in wages during that year was $256,834. In 1902 the production amounted to 901,912 short tons, valued at $1,477,245, or an average of $1.64 per ton. The wages paid in 1902 amounted to $991,391. Of the total product in 1902, 696,005 short tons, worth $1,326,155, were bituminous coal, and 205,907 short tons, worth $151,090, were of the lignite variety. There were 7 counties in which bituminous coal was produced in 1902 and 9 which produced lignite. The production of lignite in the state during the census year was considerably reduced by reason of the large production and use of crude petroleum for fuel.

The following table shows the production of coal in Texas in 1902, by groups of counties, and the distribution of the product for consumption:

Table 48.—*Coal production of Texas, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	887,167	5,591	9,154	901,912	$1,477,245	$1.64
Bituminous:						
Eastland Erath Maverick Parker Webb Wise Young	683,345	4,881	7,779	696,005	1,326,155	1.91
Lignite:						
Anderson Bastrop Houston Medina Milam Rains Robertson Shelby Wood	203,822	710	1,375	205,907	151,090	0.73

Utah.—The coal fields of Utah belong to the areas included in the Rocky mountain region. Comparatively little is known in regard to the total areas underlain by coal in this state, as they have received less attention than those in most of the other states of the Rocky mountain system. The principal exploration and developments have been along the lines of transportation, and even here only in somewhat scattered localities. It is therefore impossible to estimate with any degree of accuracy the entire productive area. The known coal fields are estimated to contain about 2,000 square miles. The principal field is located in Carbon, Emery, and Uinta counties, and is an extension westward of the Grand River field of Colorado. So far as known, it exists in a comparatively narrow strip running first southwest and then northwest from the Colorado state line, between the 39th and 40th degrees of latitude. It is traversed near its western limit by the Rio Grande Western Railway, along the line of which the producing mines are located. There is also a somewhat extensive area in the southwestern portion of the state, and one in the southern central portion, neither of which has been developed to any extent on account of its distance from railroad transportation.

The quality of the Utah coal varies from lignite to semibituminous, but none of the lignite beds are operated at the present time. The principal production is of bituminous coal, some of which makes a fairly good coke. Of the total production in 1902, 230,215 short tons were made into coke in Carbon county, which is the principal coal producing county in the state, 95.8 per cent of the total output in 1902 being mined there.

The Tenth Census, covering the fiscal year ending June 30, 1880, reported the coal production of Utah at 14,748 short tons, valued at $33,645. During the calendar year 1889 the output, as reported at the Eleventh Census, was 236,651 short tons, valued at $377,456, or an average of $1.59 per ton. In 1902 the production was 1,574,521 short tons, valued at $1,797,454, or an average of $1.14 per ton.

The statistics of production and distribution, by counties, in 1902 are shown in the following table:

Table 49.—*Coal production of Utah, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	1,277,343	21,531	45,432	230,215	1,574,521	$1,797,454	$1.14
Carbon	1,226,542	8,501	42,431	230,215	1,507,689	1,697,986	1.13
Emery		4,718			4,718	5,250	1.11
Summit	42,460	4,062	3,001		49,523	70,136	1.42
Uinta	1,200	2,340			3,540	6,250	1.77
Iron Sanpete	7,141	1,910			9,051	17,832	1.97

The statistics of the industry, Carbon county being given separately, are shown in the following table:

Table 50.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	39	36	67	$80,065	1,576	$1,254,090	$540	2	$94,123	$196,114	1,574,521	$1,797,454
Carbon	10	8	59	73,255	1,494	1,191,873	540	2	87,057	185,188	1,507,689	1,697,986
Other counties[1]	29	28	8	6,810	82	62,217			7,066	10,926	66,832	99,468

[1] Includes Emery, Iron, Sanpete, Summit, and Uinta.

Virginia.—There are three distinct coal producing areas in Virginia. The first of these is the Richmond basin, embracing Henrico, Chesterfield, and Goochland counties, and parts of Powhatan and Amelia, in the eastern portion of the state. This area is placed first, not because of its importance in production at present, but because of the fact that the earliest production of bituminous coal in the United States, as far as known, was obtained from it. The second is an isolated area found in Montgomery and Pulaski counties, in the southwestern portion of the state, where some semianthracite is produced, principally for local consumption. The third, and by far the most important in point of production and area, is the portion of the great Appalachian region which crosses the southwestern corner of the state. A portion of this area, in Tazewell county, contains the famous Pocahontas bed, one of the highest grades of coking and steam coal to be found in the United States. The coal beds in Wise county appear to be a continuation of the Middlesboro coal series of Kentucky. There are found within this coal bearing series in Wise county six different coal seams, all of which are of workable thickness. Developments in Wise county began with the construction of the Clinch valley branch of the Norfolk and Western Railway. It is now by far the most important coal producing county in the state, 76.1 per cent of the entire output being mined in this district.

Although now of little commercial importance, the Richmond basin of Virginia was the first bituminous coal area in the United States to be developed, it having been reported that about fifty-four thousand tons were produced here in 1822. Ten years later, in 1832, the production is reported to have amounted to 132,000 short tons. With the development of other areas more favorably endowed in quality of coal and in ease of mining it, the importance of the Richmond basin as a source of supply rapidly waned, and by the middle of the last century production had almost entirely ceased. Attempts to reestablish the industry in this district in recent years have proved expensive and unsuccessful, and although a small amount continues to be mined for restricted local consumption the field is practically abandoned.

With the development of the Pocahontas region which followed the construction of the Norfolk and Western Railway in 1883, Virginia resumed some importance as a coal producing state. In the census year ending June 30, 1880, the production of the state was reported as 43,079 short tons, valued at $99,802. The first coal shipped from the Pocahontas or Flat Top region (which includes McDowell and Mercer counties in West Virginia as well as Tazewell county in Virginia) was from the Virginia side of the line. This shipment was made by the Southwest Virginia Improvement Company from Pocahontas, and amounted to 68,127 short tons. In the calendar year 1889, according to the Eleventh Census, the production of the state was 865,786 short tons, valued at $804,475, all but about 200,000 tons of this product being from the Pocahontas mines in Tazewell county. The development work in Wise county began in 1891 with the building of the Clinch valley extension of the Norfolk and Western Railway. Shipments began from this new field in 1893. In 1902 the production was 3,182,993 short tons, valued at $2,543,595. The average price per ton in 1889 was 93 cents. In 1902 it was 80 cents.

The statistics of production, by counties, and the distribution of the product for consumption are shown in the following table:

TABLE 51.—*Coal production of Virginia, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at the mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	1,444,559	20,916	32,447	1,685,071	3,182,993	$2,543,595	$0.80
Montgomery	7,911	4,875	....	....	12,786	30,716	2.40
Tazewell	538,854	9,232	13,216	162,451	723,753	684,663	0.95
Wise	875,257	6,809	17,731	1,522,620	2,422,417	1,782,583	0.74
Chesterfield Pulaski	22,537	....	1,500	....	24,037	45,633	1.90

The statistics for the mining of coal in Virginia, in 1902, by counties, are as follows:

TABLE 52.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	26	22	179	$155,930	2,704	$1,407,867	$27,000	52	$315,384	$215,458	3,182,993	$2,543,595
Tazewell	3	3	39	37,050	477	268,715	....	....	122,075	57,515	723,753	684,663
Wise	12	8	133	114,855	2,119	1,101,863	27,000	52	190,104	155,582	2,422,417	1,782,583
Other counties[1]	11	11	7	1,025	108	37,289	....	....	3,205	2,361	36,823	76,349

[1] Includes Chesterfield, Montgomery, and Pulaski.

Washington.—The coal fields of Washington are found in the western and central portions of the state. There are four principal basins or areas, three of them in the western part of the state, lying in an almost directly north and south line, and one in Kittitas county, near the center. The three former are known as the Northern and Southern Puget Sound coal fields and the Southwestern coal field. The field in Kittitas county, in the central portion of the state, has been designated as the Roslyn basin, from the location of some of its principal operations. The Northern Puget Sound field includes the coal mines located in Skagit and Whatcom counties, in the northwestern corner of the state. The Southern Puget Sound coal field includes the coal areas in King, Pierce, and Thurston counties, east of the cities of Seattle and Tacoma. The Southwestern field is a small one, lying directly south of Puget sound. The Roslyn field, in Kittitas county, is the most important one in point of production, nearly one-half of the entire output of the state being mined in this county.

Washington is the only one of the Pacific coast states producing true coal, all of the product of California and Oregon being lignite. Some of the Washington coals approach anthracite in character, and some natural coke has been found. A small amount of lignite is also produced in the state. Some of the bituminous coals make a fair grade of coke, and some coke is manufactured in the state each year.

Coal mining began in the middle of the last century, in the vicinity of Bellingham bay, in the northwestern part of the then territory of Washington. Operations in this locality were discontinued in 1879 and have not been resumed. Active development of the other coal fields of the state began about 1882, since which time there has been an almost steady growth in output. At the Tenth Census the coal production from Washington was 145,015 short tons, valued at $389,046. In 1889, according to the Eleventh Census, the output was 1,030,578 short tons, valued at $2,393,238, or an average of $2.32 per ton. Washington's coal production in 1902 was 2,681,214 short tons, valued at $4,572,295, or an average of $1.71 per ton.

The amount paid in wages in 1889 was $1,747,080. The wages paid in 1902 amounted to $3,220,263.

In the following table are shown the details of production, by counties, during 1902, with the distribution of the product for consumption:

Table 53.—*Coal production of Washington, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	2,498,177	29,287	97,003	56,747	2,681,214	$4,572,295	$1.71
King	940,140	18,017	59,731	....	1,017,888	1,988,325	1.95
Kittitas	1,224,371	7,805	18,744	....	1,250,920	1,712,780	1.37
Pierce	311,630	2,539	13,288	56,146	383,603	799,774	2.08
Other counties[1]	22,036	926	5,240	601	28,803	71,416	2.48

[1] Includes Lewis, Skagit, and Whatcom.

The statistics for the industry are shown in the following table, counties having an output of 200,000 tons or more being given separately:

Table 54.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	27	22	160	$221,915	3,931	$3,220,263	$200	3	$180,213	$475,254	2,681,214	$4,572,295
King	13	8	61	77,958	1,522	1,216,451	200	3	93,008	190,352	1,017,888	1,988,325
Kittitas	4	4	28	59,010	1,525	1,332,133	....	....	29,092	166,150	1,250,920	1,712,780
Pierce	7	7	61	75,375	775	589,611	....	....	53,807	107,154	383,603	799,774
Other counties[1]	3	3	10	9,572	109	82,068	....	....	4,306	11,598	28,803	71,416

[1] Includes Lewis, Skagit, and Whatcom.

West Virginia.—In the amount of area underlaid by coal West Virginia ranks first among the Eastern states, the coal fields of which belong to the Appalachian system. Nearly the entire state (17,280 square miles in all) is included in the coal bearing regions. Within the boundaries of this great coal field in West Virginia there are no less than 21 workable coal seams, chief among which is the Pittsburg bed, which underlies a large portion of southeastern Ohio, southwestern Pennsylvania, and furnishes the famous Big Vein of Maryland's coal areas. This great bed in West Virginia extends from the northern boundaries of the state, where it occurs at the bottom of the upper productive measures, to the Flat Top or Pocahontas districts, in the southern portion, where it is found among the lower coal measures. In the northern part of the state the Pittsburg bed attains a thickness of from 14 to 16 feet, and is exceptionally free from impurities in the form of slate partings or sulphur bands.

No state in the Union is more favored by nature in the number and extent of its bituminous coal seams and in the variety of high-grade qualities of coal than is West Virginia. The best grades of coking, gas, steam, and domestic coals are produced within its borders.

The principal developments in coal production have been along the lines of the three railroad systems crossing the state from east to west. These are the Baltimore and Ohio, which crosses the northern part of the state from Piedmont to Parkersburg, and the Chesapeake and Ohio, and the Norfolk and Western, which traverse the southern coal fields, the former from Hinton and the latter from Pocahontas, on the east, to the Ohio river, on the west. The Coal and Coke Railroad, now building from Elkins to Charleston, and the extensions by the Wabash interests, which have secured control of the West Virginia Central and Pittsburg Railway, are expected to develop some of the rich coal lands in the interior of the state in the near future. The Deepwater Railroad, building from the station of Deepwater, on the Chesapeake and Ohio, to the Norfolk and Western Railway, will reach hitherto untouched areas lying between those railroads.

West Virginia ranked third in 1902 among the coal producing states, with Pennsylvania first and Illinois second; but with the completion of the railroad extensions now in progress and the additional tonnage which will result therefrom, the chances are that it will in a few years, at most, rank next to Pennsylvania.

Coal production in West Virginia began about 1860 and was entirely from the Piedmont region, to which the Baltimore and Ohio Railroad gave access. Until the completion of the Chesapeake and Ohio and the Norfolk and Western railways all of the output was from the northern part of the state. The Tenth Census, covering the fiscal year ending June 30, 1880, reported the production of coal in West Virginia at 1,829,844 short tons, valued at $2,013,671, or an average of $1.10 per ton. In the calendar year 1889, according to the Eleventh Census, the production was 6,231,880 short tons, valued at $5,086,584, or an average of 82 cents per ton. In 1902 the production amounted to 24,570,826 short tons, valued at $24,748,658, or an average of $1.01 per ton.

A relatively small amount of coal is consumed at iron works in the vicinity of Wheeling, at salt works along the Ohio river, and in some unimportant manufacturing establishments throughout the state. But with these exceptions all of the product, save that for household consumption, is shipped out of the state or is used by the railroads engaged in its transportation. Large quantities are shipped from the eastern parts of the state to the seaports of Baltimore, Norfolk, and Newport News, and from these ports to coastwise and foreign markets, and from the western fields by rail and river to interior and gulf points.

The production by counties in 1902, with the distribution of the product for consumption, is shown in the following table:

TABLE 55.—*Coal production of West Virginia, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	19,847,321	623,903	267,885	3,831,717	24,570,826	$24,748,658	$1.01
Barbour	455,511	21,835	9,801	25,578	512,725	560,068	1.09
Braxton		4,910			4,910	5,665	1.15
Brooke	36,350	3,847	175		40,372	53,868	1.33
Fayette	3,979,127	48,570	54,731	692,684	4,775,112	5,832,098	1.22
Gilmer		3,440			3,440	3,490	1.01
Grant	28	2,748			2,776	3,226	1.16
Hancock	25,623	53,721	1,056		80,400	108,953	1.36
Harrison	1,935,727	22,920	26,166	81,784	2,066,597	1,985,078	0.96
Kanawha	1,765,272	31,423	13,341	38,581	1,848,617	2,226,383	1.20
Lewis		540			540	405	0.75
McDowell	3,761,702	67,210	45,514	1,585,229	5,459,655	4,768,455	0.87
Marion	2,817,880	24,841	54,676	499,797	3,397,194	3,090,184	0.91
Marshall	159,484	79,090	5,217		243,791	245,350	1.01
Mason	73,105	68,587	3,035		144,727	148,251	1.02
Mercer	993,838	9,166	6,291	238,964	1,248,279	1,100,423	0.88
Mineral	509,796	5,096	101		514,993	450,168	0.87
Mingo	794,358	7,844	3,972		806,174	786,165	0.98
Monongalia	95,774	1,943	437	65,320	163,474	124,968	0.81
Ohio	137,961	90,772	1,508		230,241	243,758	1.06
Preston	512,641	23,146	14,553	40,096	590,436	698,447	1.18
Putnam	182,087	1,146	1,026		184,259	274,992	1.49
Raleigh	273,548	3,327	1,942		281,817	359,251	1.27
Randolph	310,929	4,965	625	83,626	400,145	410,945	1.03
Taylor	353,014	13,474	2,162		368,650	339,459	0.92
Tucker	634,094	23,792	18,156	490,008	1,166,050	858,245	0.74
Other counties¹	39,452	5,570	400		45,422	70,370	1.55

¹ Includes Clay, Nicholas, Ritchie, and Upshur.

The statistics of the industry in the counties, the production of which was 200,000 short tons or more, are shown in the following table:

TABLE 56.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	522	406	1,987	$1,766,448	23,914	$13,524,429	$23,092	79	$2,087,528	$2,327,877	24,570,826	$24,748,658
Barbour	26	25	44	41,500	621	336,446			12,865	85,550	512,725	560,068
Fayette	64	63	427	396,912	5,227	3,131,412			533,673	476,728	4,775,112	5,832,098
Harrison	62	40	243	220,825	1,868	1,090,431			266,012	280,506	2,066,597	1,985,078
Kanawha	54	37	222	159,379	2,326	1,291,561			170,191	181,840	1,848,617	2,226,383
McDowell	46	43	306	264,890	4,648	2,509,446	13,580	39	501,267	360,261	5,459,655	4,768,455
Marion	29	12	225	216,392	2,457	1,407,444	1,500	3	196,974	242,814	3,397,194	3,090,184
Marshall	5	5	18	15,051	215	152,135			9,236	17,877	243,791	245,350
Mercer	34	13	78	76,102	990	545,140	4,050	6	131,240	159,983	1,248,279	1,100,423
Mineral	16	11	22	14,997	479	297,486	300	3	11,023	40,840	514,993	450,168
Mingo	22	12	77	63,960	1,006	480,180			89,527	49,907	806,174	786,165
Ohio	12	12	22	15,841	287	172,321			11,411	15,724	230,241	243,758
Preston	41	37	53	39,785	614	370,285	1,000	7	12,813	89,835	590,436	698,447
Raleigh	6	6	33	28,909	307	234,570			49,885	15,894	281,817	359,251
Randolph	10	7	44	42,249	291	186,369	2,239	15	8,040	33,863	400,145	410,945
Taylor	18	17	33	29,050	335	192,381			28,215	34,580	368,650	339,459
Tucker	9	2	66	81,296	1,270	675,394			20,450	143,254	1,166,050	858,245
Other counties¹	68	64	75	59,810	853	491,428	423	6	43,576	98,421	670,320	794,181

¹ Includes Braxton, Brooke, Clay, Gilmer, Grant, Hancock, Lewis, Mason, Monongalia, Nicholas, Putnam, Ritchie, and Upshur.

Wyoming.—The coal fields of Wyoming are included among those of the Rocky mountain area, although most of the productive areas are in the plains region, east of the mountain ranges. There are no less than fourteen different and rather widely separated fields distributed throughout the state. These different areas are known as (1) the Black Hills field, located in Converse and Weston counties, in the northeastern part of the state; (2) the Casper field, a small bituminous area in the eastern part of Natrona county; (3) the Carbon field, and (4) the Hanna field, both in Carbon county; (5) the Rawlins field, in the western part of Carbon and eastern part of Sweetwater county; (6) the Rock Springs field, and (7) the Henrys Fork field, both in Sweetwater county; (8) the Hams Fork, (9) the Almy, and (10) the Sublette fields in Fremont county; (13) the Bighorn, and (14) the Powder river fields in Bighorn county, in the north-central part of the state.

The principal developments have been in the several fields of Carbon, Sweetwater, and Uinta counties, which are traversed by the Union Pacific Railroad, and, to a less extent, in Converse, Natrona, Sheridan, and Weston counties, reached by a branch of the Burlington system. Sweetwater and Uinta counties together produced 72 per cent of the state's total output in 1902.

Coal mining in what is now the state of Wyoming began in 1865 with a product of 800 tons, so far as recorded. In 1868 the production of the then territory amounted to 6,925 short tons, and in 1870 the output was 105,295 short tons. The Tenth Census reported a production of 589,595 short tons, valued at $1,080,451, or an average of $1.83 per ton. According to the Eleventh Census, the production in the calendar year 1889 was 1,388,947 short tons, valued at $1,748,617, or $1.26 per ton. In 1902 the output was 4,429,491 short tons, worth $5,236,339, an average of $1.18 per ton. At the Tenth Census the total wages paid were $579,566; at the Eleventh Census the wages paid amounted to $1,553,947, and in 1902 they were $3,207,545.

The statistics of production, by counties, in 1902, with the distribution of the product for consumption, are shown in the following table:

TABLE 57.—*Coal production of Wyoming, by counties: 1902.*

COUNTY.	Loaded at mines for shipment (short tons).	Sold to local trade and used by employes (short tons).	Used at the mines for steam and heat (short tons).	Made into coke (short tons).	Total quantity (short tons).	Total value.	Average price per ton.
Total	4,144,450	37,101	209,455	38,485	4,429,491	$5,236,339	$1.18
Carbon	352,667	3,374	26,166	....	382,207	461,338	1.21
Converse	65,184	945	6,200	....	72,329	95,690	1.32
Sweetwater	1,517,583	8,886	68,871	....	1,595,340	1,821,545	1.14
Uinta	1,520,636	14,945	59,527	225	1,595,333	1,756,365	1.10
Other counties[1]	688,380	8,951	48,691	38,260	784,282	1,101,401	1.40

[1] Includes Bighorn, Crook, Fremont, Johnson, Natrona, Sheridan, and Weston.

The statistics for the industry during 1902 are shown, by counties producing 200,000 tons or more, in the following table:

TABLE 58.—SUMMARY BY COUNTIES HAVING A PRODUCTION OF 200,000 TONS OR OVER: 1902.

COUNTY.	Number of mines.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	PRODUCT.	
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			Quantity (short tons).	Value.
Total	36	22	125	$159,153	4,197	$3,207,545	$12,747	17	$224,947	$669,328	4,429,491	$5,236,339
Carbon	5	4	19	23,347	486	362,299	....	....	6	59,144	382,207	461,338
Uinta	9	3	42	51,921	1,289	1,085,018	....	....	148,428	311,072	1,595,333	1,756,365
Other counties[1]	22	15	64	83,885	2,422	1,760,228	12,747	17	76,513	299,112	2,451,951	3,018,636

[1] Includes Bighorn, Converse, Crook, Fremont, Johnson, Natrona, Sheridan, Sweetwater, and Weston. (Sweetwater and Weston counties each had a production exceeding 200,000 tons, but are not shown separately in order to avoid disclosing the operations of individual operators.)

Occurrence.—The bituminous coal fields are scattered widely over the United States and include altogether an area of something over three hundred and thirty-five thousand square miles. It has been customary to consider as bituminous coal all varieties from lignite to semianthracite. The different varieties merge into each other by such indistinguishable gradations that no absolute line of demarcation is possible. The general term of "bituminous" coal as used in this report includes, therefore, lignite or brown coal, cannel, block, splint, semibituminous, semianthracite, and, as stated, the small anthracite product of Colorado and New Mexico.

The bituminous areas have been divided by the United States Geological Survey into the following subdivisions: (1) Triassic, (2) Appalachian, (3) Northern, (4) Central, (5) Western, (6) Rocky Mountain, and (7) Pacific Coast. They are described briefly, as follows:

1. The Triassic field embraces the coal beds of the Triassic or New Red Sandstone formation, and is worked in the counties of Chesterfield and Henrico in Virginia (generally known as the Richmond basin), and

the coal along the Deep and Dan rivers in Chatham county, N. C. The earliest production of bituminous coal in the United States was made in the Richmond basin of Virginia. The first production from the small area in North Carolina was reported in the census year 1889. Only one commercial mine has been opened in the region and the production has not reached any large proportions during the fourteen years that the mine has been operated.

2. The Appalachian field, which extends from the northern part of Pennsylvania on the north to the central part of Alabama on the south, follows in a southwest direction the Appalachian mountain system. Its entire length is a little over 900 miles and ranges in width from 30 to 180 miles. The area of the coal fields of the Appalachian region is estimated at 70,807 miles, the productive area covering nearly all of western Pennsylvania, the eastern part of Ohio, the western part of Maryland, the southwestern corner of Virginia, nearly all of West Virginia, the eastern part of Kentucky, the east-central part of Tennessee, the northwestern corner of Georgia, and nearly all of northern Alabama.

All of the coals produced in this region are of a bituminous or semibituminous variety, except for a small amount of semianthracite mined in Montgomery county, in the southwestern part of Virginia. Within this region is found bituminous coal of nearly every variety of chemical composition and physical structure. Within its boundaries are found the famous Connellsville coking coal, in Fayette and Westmoreland counties, Pa.; the Clearfield and Pittsburg steam coals; the Youghiogheny river gas coals; the famous smithing coals of Blossburg, Pa., and Cumberland, Md.; the gas and coke producing coals of the upper Potomac and upper Monongahela rivers; the Massillon and Hocking coals of Ohio, noted for their domestic qualities and for their value in the iron reducing furnaces; the coking coals of the Pocahontas Flat Top region; the steam, gas, coking, and domestic coal of the New and Kanawha river series; the Jellico coals of southeastern Kentucky and northeastern Tennessee; and the excellent coking and steam coals of southeastern Tennessee, Alabama, and northwestern Georgia.

The production of bituminous coal in the Appalachian region during 1902 was 173,274,861 short tons. In 1889, at the taking of the Eleventh Census, this region produced 62,972,222 short tons, and in 1880, at the taking of the Tenth Census, it produced 29,834,622 short tons, showing an increase in 1902 of 110,302,639 tons over 1889 and of 143,440,239 tons over 1880.

3. The Northern coal field lies altogether in the lower peninsula of Michigan, between Lake Michigan and Lake Huron, extending from Jackson county on the south to Roscommon county on the north, and from Tuscola county on the east to Kent county on the west. It embraces an area of approximately 7,500 square miles. It is the only known coal field lying in the drainage basin of the St. Lawrence river within the limits of the United States. The northeastern edge of the field is penetrated by Saginaw bay, through which, with the Saginaw river, it is given easy access to Lake Huron and thence to the ports of the Great Lakes.

Although coal was produced in this region as early as 1835, it is only within the last few years that the production has amounted to any great importance. In 1880 the Northern coal field produced 100,800 short tons; in 1889 the output had fallen to 67,431 tons. The active development of the region really began in 1897 and by 1901 the production had amounted to 1,241,241 short tons. Labor troubles in the census year of 1902 reduced the output to 964,718 short tons.

4. The Central coal field includes all the coal producing areas of Indiana, Illinois, and western Kentucky. It extends from the northern part of Illinois (most of the central and southern parts of the state being underlain by workable coal seams) to the central part of western Kentucky. The field is estimated to contain an area of 42,900 square miles in Illinois, 9,300 square miles in Indiana, and 5,800 square miles in Kentucky, making a total for the entire field of 58,000 square miles. The coal field underlies 80 counties in Illinois, 26 in Indiana, and 20 in Kentucky, although coal is not at present mined in all of the counties in any of the three states.

It is from the Indiana portion of this field that most of the well-known "block" domestic coal is produced. In the Kentucky portion of the field the coal grades into a quality suitable for coking purposes, and considerable quantities of coke are produced in this portion of the field, although practically no coke is made in either Illinois or Indiana.

The Central coal field, while fourth in size among the coal fields of the United States, is second in producing importance. Illinois, which contains nearly three-fourths of the entire area, was second in 1902 among the coal producing states. The production from this entire field in 1902 was 46,133,024 short tons, an increase of a little over 180 per cent as compared with 1889, when the production was 16,240,314 tons, and of 466 per cent as compared with 1880, when the production was 8,150,195 tons.

5. The Western coal field forms a practically continuous belt of coal measure rocks from northern Iowa in a southwesterly direction through central Texas to the Rio Grande, a distance of 880 miles, and underlying a total of 94,076 square miles. It includes the coal bearing areas of Iowa, Missouri, Nebraska, Kansas, Indian Territory, Arkansas, and Texas.

Within its boundaries are found all the varieties included under the general head of bituminous coal, from lignite to semianthracite, immense areas in Texas being underlain by lignite, while semianthracite is found in Indian Territory and Arkansas. Coking coals are produced in Indian Territory, cannel coal is produced in Missouri, and block coal is mined in Iowa. Most of the coal produced is of the dry, noncoking variety of bituminous coal.

The production in the census year of 1902 amounted to 20,727,495 short tons, as compared with 10,036,356 short tons in 1889 and 3,212,787 short tons in 1880. The development in this region during the last twenty years has been of extraordinary rapidity.

6. The Rocky Mountain coal field includes the productive areas in the states lying along the Rocky mountain range and also those of North Dakota, although the coal fields of the latter state do not lie within the Rocky mountain system. The states from which coal has been produced in this field are Colorado, Idaho, Montana, Nevada, North Dakota, Utah, and Wyoming, and the territory of New Mexico. Idaho and Nevada have produced insignificant amounts for purely local consumption. South Dakota has produced an insignificant amount of lignite, but none in the last few years. The known areas cover a little over one hundred thousand square miles of territory.

The production from the entire region in 1902 was 16,149,545 short tons, as compared with 5,048,413 short tons in 1889 and 1,067,314 short tons in 1880.

7. The Pacific Coast field embraces the coal producing areas in the 3 states bordering on the Pacific ocean—California, Oregon, and Washington. The coals are all of the Tertiary age and are largely lignitic in character. The only bituminous coal produced in the Pacific coast region is mined in Washington, all of the product from California and Oregon being lignite. Some of the bituminous coals in Washington possess good coking qualities, and some coke is made in the state each year.

The first production in this region was, so far as known, in California in 1861. The first coal mined in Washington was, so far as known, produced in 1880, and it was not until 1885 that any coal was reported to have been produced in Oregon. All of the growth in the last two decades has been in the Washington coal fields. The production in California has decreased since 1880. The production of Oregon in 1902 was about the same as in 1889, and 30 per cent more than in 1885. The production of Washington, however, has increased from 145,015 short tons in 1880 to 1,030,578 tons in 1889 and 2,681,214 tons in 1902. The production from the entire field has increased from 425,170 short tons in 1880 to 1,214,757 tons in 1889 and to 2,834,058 tons in 1902. A small production from Alaska, 2,212 tons, is included in this production for 1902.

Table 59 is a detailed summary of the anthracite coal industry by counties, and Table 60 is a detailed summary of the bituminous coal industry by states and territories.

TABLE 59.—COAL, PENNSYLVANIA ANTHRACITE—DETAILED SUMMARY, BY COUNTIES: 1902.

	Total.	Carbon.	Lackawanna.	Luzerne.	Northumberland.	Schuylkill.	Other counties.[1]
Number of mines	334	11	91	116	21	85	10
Number of operators	119	6	23	36	12	35	7
Character of ownership:							
Individual	9	1		3	1	3	1
Firm	34	1	10	8	2	13	
Incorporated company	76	4	13	25	9	19	6
Salaried officials, clerks, etc.:							
Total number	3,014	87	483	843	330	1,108	163
Total salaries	$2,907,293	$82,814	$461,964	$839,080	$204,319	$1,168,728	$120,288
General officers—							
Number	131	5	28	42	8	44	4
Salaries	$383,681	$15,376	$58,690	$100,621	$34,423	$168,781	$5,790
Superintendents, etc.—							
Number	848	26	168	275	92	236	51
Salaries	$1,035,280	$26,531	$192,703	$330,956	$89,142	$351,567	$41,168
Foremen below ground—							
Number	998	53	147	218	129	406	45
Salaries	$812,891	$19,528	$140,497	$228,520	$94,513	$291,614	$38,189
Clerks—							
Number	1,034	33	140	278	123	409	51
Salaries	$698,548	$21,546	$90,074	$178,983	$56,411	$256,475	$32,081
Wage-earners:							
Aggregate average number	69,691	2,114	16,175	25,001	6,691	16,385	3,325
Aggregate wages	$38,716,113	$1,111,578	$9,565,166	$13,939,752	$3,530,366	$8,600,384	$1,968,867
Above ground—							
Total average number	27,964	1,014	6,042	9,474	2,579	7,594	1,261
Total wages	$12,132,983	$457,644	$2,601,875	$4,080,050	$1,098,726	$3,329,705	$564,983
Engineers, firemen, etc.—							
Average number	6,513	217	1,083	2,279	651	1,949	334
Wages	$3,886,505	$120,164	$703,183	$1,394,739	$324,674	$1,146,374	$197,371
Boys under 16 years—							
Average number	3,822	136	483	1,025	546	1,487	145
Wages	$780,153	$30,380	$98,475	$183,922	$124,436	$315,882	$27,058
All other wage-earners—							
Average number	17,629	661	4,476	6,170	1,382	4,158	782
Wages	$7,466,325	$307,100	$1,800,217	$2,501,389	$649,616	$1,867,449	$340,554
Below ground—							
Total average number	41,727	1,100	10,133	15,527	4,112	8,791	2,064
Total wages	$26,583,130	$653,934	$6,963,291	$9,859,702	$2,431,640	$5,270,679	$1,403,884
Miners—							
Average number	17,767	306	4,646	6,051	2,026	3,730	1,008
Wages	$14,364,005	$233,524	$4,360,513	$5,022,847	$1,389,177	$2,551,587	$806,327
Miners' helpers—							
Average number	6,921	248	1,167	3,025	546	1,709	226
Wages	$3,646,886	$128,131	$589,030	$1,601,735	$278,052	$906,227	$116,715
Boys under 16 years—							
Average number	742	23	165	284	49	191	30
Wages	$182,352	$5,750	$43,806	$67,024	$12,254	$45,162	$8,356
All other wage-earners—							
Average number	16,297	523	4,155	6,167	1,491	3,161	800
Wages	$8,391,870	$286,529	$1,969,912	$3,168,096	$778,117	$1,746,703	$472,486
Average number of wage-earners employed each month:							
Men 16 years and over—							
January	110,018	3,530	25,062	39,829	11,273	25,516	4,808
February	110,760	3,493	25,066	39,912	11,193	26,190	4,906
March	109,165	3,320	24,872	38,469	11,140	26,486	4,878
April	109,190	3,364	24,590	39,155	11,127	25,981	4,973
May	53,169	1,945	13,178	20,212	3,448	11,571	2,815
June	16,301	460	2,428	9,156	526	2,394	1,337
July	6,493	209	2,114	2,752	74	702	642
August	7,610	220	2,955	2,947	79	775	634
September	8,136	255	3,165	3,131	84	840	661
October	34,773	1,043	11,117	10,896	2,227	6,916	2,574
November	105,516	2,586	25,844	37,745	10,794	23,855	4,692
December	110,393	3,024	25,993	40,100	11,188	25,256	4,890
Boys under 16 years—							
January	8,362	303	1,100	2,483	1,142	3,043	291
February	8,468	265	1,089	2,470	1,153	3,196	295
March	8,419	273	1,096	2,423	1,141	3,190	296
April	8,517	314	1,113	2,489	1,149	3,160	292
May	2,986	147	599	797	211	1,032	200
June	52		11	4			37
July	59		11	4		10	34
August	96		23	8		27	38
September	100	3	25	8		27	37
October	1,696	81	426	432	91	612	55
November	7,804	244	1,192	2,196	1,121	2,791	260
December	8,209	278	1,191	2,374	1,143	2,948	275
Average number of wage-earners at specified daily rates of pay:							
Engineers—							
$0.75 to $0.99	3			1	1	1	
$1.00 to $1.24	49		1	11	10	26	1
$1.25 to $1.49	68	3	9	27	12	17	
$1.50 to $1.74	273	12	25	89	46	96	5
$1.75 to $1.99	455	18	51	124	37	198	27
$2.00 to $2.24	509	35	64	121	51	194	44
$2.25 to $2.49	217	4	23	109	10	70	1
$2.50 to $2.74	379		147	207	2	19	4
$2.75 to $2.99	75		55	11		9	
$3.00 to $3.24	13			12		1	
$3.25 to $3.49	1		1				
Firemen—							
$1.00 to $1.24	9		1	5	3		
$1.25 to $1.49	123	11	29	32	24	27	
$1.50 to $1.74	621	30	112	176	92	149	62
$1.75 to $1.99	815	28	90	253	84	342	18
$2.00 to $2.24	219		86	79	3	41	10
$2.25 to $2.49	21		7	6		7	1
$2.50 to $2.74	27		3	8		16	
$2.75 to $2.99	1		1				

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[1] Includes operators distributed as follows: Columbia, 2 (4 mines); Dauphin, 2; Sullivan, 2; Susquehanna, 1 (2 mines).

TABLE 59.—COAL, PENNSYLVANIA ANTHRACITE—DETAILED SUMMARY, BY COUNTIES: 1902—Continued.

	Total.	Carbon.	Lackawanna.	Luzerne.	Northumberland.	Schuylkill.	Other counties.
Average number of wage-earners at specified daily rates of pay—Continued.							
Machinists, blacksmiths, carpenters, and other mechanics—							
$0.75 to $0.99	1			1			
$1.00 to $1.24	20			4	2	14	
$1.25 to $1.49	67	3	2	22	17	22	1
$1.50 to $1.74	371	6	28	100	41	175	21
$1.75 to $1.99	428	18	49	178	60	82	41
$2.00 to $2.24	823	18	147	414	69	138	37
$2.25 to $2.49	673	7	94	205	61	273	33
$2.50 to $2.74	156	1	38	41	11	42	23
$2.75 to $2.99	47		12	21	4	8	2
$3.00 to $3.24	20			13	2	2	3
$3.25 to $3.49	2			1		1	
$3.50 to $3.74	1		3	1			
$4.00 to $4.24	1					1	
Miners—							
$1.25 to $1.49	26			3	22	1	
$1.50 to $1.74	271	56	56	148	7	4	
$1.75 to $1.99	1,101		246	271	136	448	
$2.00 to $2.24	3,293	2	143	501	914	1,272	461
$2.25 to $2.49	3,770	2	572	1,426	463	1,176	131
$2.50 to $2.74	2,195	122	117	1,398	99	376	83
$2.75 to $2.99	1,512	67	337	489	389	228	2
$3.00 to $3.24	1,922	42	716	842	26	170	126
$3.25 to $3.49	1,373		1,044	322		7	
$3.50 to $3.74	1,313		825	360		71	57
$3.75 to $3.99	517	15	109	392			1
$4.00 to $4.24	166		160	1			5
$4.25 and over	502		210	150			142
Miners' helpers—							
$0.75 to $0.99	2				2		
$1.00 to $1.24	441	8	146	242	29	3	13
$1.25 to $1.49	947	40	298	528	52	21	8
$1.50 to $1.74	921	16	115	447	160	89	64
$1.75 to $1.99	2,104	100	89	626	240	996	53
$2.00 to $2.24	1,196	63	372	392	53	249	98
$2.25 to $2.49	1,211	30	125	714	10	330	2
$2.50 to $2.74	117		12	96		9	
Timbermen and track layers—							
$0.75 to $0.99	2			1		1	
$1.00 to $1.24	50	6		33	1	9	1
$1.25 to $1.49	61	7	3	21	18	8	4
$1.50 to $1.74	304	4	15	43	82	89	71
$1.75 to $1.99	624	84	23	186	92	212	27
$2.00 to $2.24	331	1	58	176	14	50	32
$2.25 to $2.49	549	63	10	179	38	248	11
$2.50 to $2.74	23		1	11		11	
$2.75 to $2.99	5	1		1	1	2	
$3.00 to $3.24	2				1	1	
$3.25 to $3.49	1						1
Boys under 16 years—							
Less than $0.50	69	5	1	36	1	10	16
$0.50 to $0.74	2,006	84	397	696	220	543	66
$0.75 to $0.99	1,881	70	172	509	258	827	45
$1.00 to $1.24	580		71	58	114	290	47
$1.25 to $1.49	26		7	10	2	6	1
$1.50 to $1.74	2					2	
All other wage-earners—							
Less than $0.50	1						1
$0.50 to $0.74	453	27	21	358	10	7	27
$0.75 to $0.99	1,919	78	426	1,038	93	220	64
$1.00 to $1.24	5,397	160	2,323	1,593	269	886	166
$1.25 to $1.49	7,177	244	1,959	2,739	662	1,373	200
$1.50 to $1.74	7,949	214	2,452	2,216	973	1,739	355
$1.75 to $1.99	6,038	96	1,015	2,246	537	1,801	343
$2.00 to $2.24	1,790	35	180	984	43	321	227
$2.25 to $2.49	746	49	78	324	28	223	44
$2.50 to $2.74	245	4	31	167	5	30	8
$2.75 to $2.99	149	111	7	19	6	6	
$3.00 to $3.24	79		1			78	
$3.25 to $3.49	3			2		1	
Contract work:							
Amount paid	$406,421	$50,697	$58,614	$151,970	$16,483	$111,249	$17,408
Number of employees	1,731	130	387	583	68	511	52
Miscellaneous expenses:							
Total	$9,307,239	$193,513	$1,955,982	$3,776,263	$690,083	$2,301,154	$390,244
Royalties and rent of mine and mining plant	$4,359,051	$92,450	$877,884	$2,065,199	$332,997	$785,784	$204,737
Rent of offices, taxes, insurance, interest, and other sundries	$4,948,188	$101,063	$1,078,098	$1,711,064	$357,086	$1,515,370	$185,507
Cost of supplies and materials	$12,740,780	$370,268	$2,441,760	$4,901,407	$1,172,183	$3,375,680	$579,172
Product:							
Quantity, long tons	36,940,710	986,201	10,779,258	12,852,836	2,878,615	7,704,202	1,739,598
Value	$76,173,586	$1,912,361	$22,551,716	$27,022,900	$5,602,584	$15,051,292	$3,119,733
Power owned:							
Total horsepower	434,220	8,603	65,925	161,460	39,774	136,002	22,456
Engines—							
Steam—							
Number	4,629	153	991	1,887	373	1,003	222
Horsepower	415,827	5,781	64,279	156,774	37,624	129,795	21,574
Gas or gasoline—							
Number	6		4				2
Horsepower	185		121				64
Other power—							
Number	254	30	21	60	54	80	9
Horsepower	18,208	2,822	1,525	4,686	2,150	6,207	818
Electric motors owned—							
Number	78		40	29	3	3	3
Horsepower	5,735		2,591	2,364	150	520	110
Supplied to other establishments, horsepower	350			350			

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY, BY STATES AND TERRITORIES: 1902.

	United States.	Alabama.	Arkansas.	California.	Colorado.	Georgia.	Illinois.	Indian Territory.	Indiana.	Iowa.
Number of mines	5,652	145	53	8	126	3	875	58	239	326
Number of operators	4,409	91	33	8	80	2	794	29	283	299
Character of ownership:										
Individual	2,044	21	4	1	28		421	2	163	120
Firm	827	7	10		16		168	8	26	84
Incorporated company	1,517	63	19	7	35	2	201	19	93	89
Other form	21				1		4		1	6
Salaried officials, clerks, etc.										
Total number	11,413	623	146	24	611	21	1,510	248	637	512
Total salaries	$14,511,921	$709,449	$148,113	$29,745	$818,445	$20,320	$1,574,852	$240,581	$530,492	$436,828
General officers—										
Number	1,741	72	12	4	49	2	191	30	94	78
Salaries	$3,220,054	$152,776	$29,358	$6,000	$155,018	$4,000	$588,675	$42,438	$126,802	$103,040
Superintendents, managers, foremen, surveyors, etc.—										
Number	1,213	168	40	12	149	6	556	82	220	121
Salaries	$4,790,038	$244,385	$43,256	$15,685	$239,339	$5,160	$300,169	$96,121	$179,437	$115,137
Foremen, below ground—										
Number	3,401	133	33	5	77	11	406	49	143	169
Salaries	$2,920,723	$117,849	$29,502	$6,200	$84,452	$7,680	$387,046	$41,849	$115,507	$125,762
Clerks—										
Number	5,058	250	61	3	336	2	357	87	180	144
Salaries	$3,581,169	$194,439	$46,002	$1,860	$339,636	$3,480	$304,911	$56,173	$108,746	$93,099
Wage-earners:										
Aggregate average number	280,658	12,930	2,574	174	7,855	168	36,617	4,763	10,593	9,439
Aggregate wages	$181,482,288	$7,841,457	$1,780,061	$120,961	$6,006,183	$74,649	$24,876,201	$3,154,267	$7,396,425	$6,251,732
Above ground—										
Total average number	36,336	1,567	454	60	1,488	76	3,713	738	1,064	1,095
Total wages	$21,701,012	$804,110	$253,503	$41,633	$1,207,900	$36,262	$2,449,583	$430,089	$669,680	$651,915
Engineers, firemen, and other mechanics—										
Average number	13,632	643	183	22	407	45	1,691	328	558	417
Wages	$9,517,316	$383,897	$129,157	$20,435	$454,538	$23,252	$1,240,251	$215,339	$392,153	$282,509
Boys under 16 years—										
Average number	896	116	15	2	38		62	26	8	6
Wages	$253,648	$33,015	$5,020	$480	$12,933		$20,589	$7,880	$2,510	$2,081
All other wage-earners—										
Average number	21,808	808	256	36	1,043	31	1,960	384	498	672
Wages	$11,930,048	$387,198	$121,046	$20,718	$740,429	$13,010	$1,188,743	$206,870	$275,017	$367,325
Below ground—										
Total average number	244,322	11,363	2,120	114	6,367	92	32,904	4,025	9,529	8,344
Total wages	$159,781,276	$7,037,347	$1,526,558	$79,328	$4,798,283	$38,387	$22,426,618	$2,724,178	$6,726,745	$5,599,817
Miners—										
Average number	189,253	8,733	1,517	66	4,819	59	25,108	2,782	7,273	6,455
Wages	$128,211,569	$5,809,433	$1,153,972	$57,613	$3,662,292	$27,090	$17,722,115	$1,945,903	$5,264,317	$4,448,385
Miners' helpers—										
Average number	3,677	173	7	22	32		641	32	63	165
Wages	$2,153,481	$73,073	$4,050	$6,000	$19,551		$520,528	$20,568	$32,724	$105,454
Boys under 16 years—										
Average number	4,792	352	32		56		850	100	117	159
Wages	$1,335,705	$114,524	$7,644		$19,983		$255,619	$28,588	$35,465	$48,725
All other wage-earners—										
Average number	46,600	2,105	564	26	1,460	33	6,305	1,111	2,076	1,565
Wages	$28,080,521	$1,040,317	$360,892	$15,715	$1,096,457	$11,297	$3,928,356	$729,119	$1,394,239	$997,253
Average number of wage-earners at specified daily rates of pay:										
Engineers—										
$0.75 to $0.99	3									
$1.00 to $1.24	8		2			1			1	
$1.25 to $1.49	46	3	3				2		5	1
$1.50 to $1.74	165	9	6		1	2	4		8	6
$1.75 to $1.99	248	30	6		1	1	9	3	12	15
$2.00 to $2.24	977	28	21		7	2	122	44	47	73
$2.25 to $2.49	754	11	9	2	5		142	38	22	27
$2.50 to $2.74	930	61	4	4	22		249	22	91	28
$2.75 to $2.99	241	4			11		50	4	18	5
$3.00 to $3.24	303	1		4	59		56		17	6
$3.25 to $3.49	50				19		10		1	
$3.50 to $3.74	34						2	8		
$3.75 to $3.99	6				1		1			
$4.00 to $4.24	11						1			
$4.25 and over	5						2			
Firemen—										
$0.50 to $0.74	1									
$0.75 to $0.99	10									
$1.00 to $1.24	32		3			4	1		2	
$1.25 to $1.49	144	26	5			4	4	1	10	3
$1.50 to $1.74	459	61	6			1	2	23	11	22
$1.75 to $1.99	721	94	24		1		113	32	39	16
$2.00 to $2.24	1,108	6	4		17		278	16	64	40
$2.25 to $2.49	283		2	1	19		29	8	16	8
$2.50 to $2.74	255			4	43	1	11	3	2	3
$2.75 to $2.99	51				13		1		1	
$3.00 to $3.24	38				7			8		
$3.25 to $3.49	5				4					
$3.50 to $3.74	2								1	
Machinists, blacksmiths, carpenters, and other mechanics—										
$0.50 to $0.74	1									1
$0.75 to $0.99	5						1			
$1.00 to $1.24	42	2	1		1	2	1		2	
$1.25 to $1.49	175	12	1			2		1	1	
$1.50 to $1.74	393	67	10		2	11	5	6	7	4
$1.75 to $1.99	601	71	9		2		25	6	22	6
$2.00 to $2.24	1,400	53	32		14	6	153	40	29	59
$2.25 to $2.49	1,876	45	19	1	3	7	239	52	35	61
$2.50 to $2.74	1,128	21	13	1	29		107	17	71	36
$2.75 to $2.99	119	54	1		17		39	10	11	5
$3.00 to $3.24	479	3		5	139	1	28	3	9	2
$3.25 to $3.49	65				19			3		
$3.50 to $3.74	76		2		10		4		2	
$3.75 to $3.99	8				2					
$4.00 to $4.24	62	1			39		1		1	
$4.25 and over	6									

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

	United States.	Alabama.	Arkansas.	California.	Colorado.	Georgia.	Illinois.	Indian Territory.	Indiana.	Iowa.
Average number of wage-earners at specified daily rates of pay—Continued.										
Miners—										
Less than $0.50	20						7		1	
$0.50 to $0.74	86				1		23		1	1
$0.75 to $0.99	342						31		10	
$1.00 to $1.24	2,515	246	10		2	10	61	101	31	18
$1.25 to $1.49	6,026	675			160	15	506	271	111	57
$1.50 to $1.74	19,088	600	85		62	19	[illegible]	79	274	418
$1.75 to $1.99	24,892	987	186		391	5	2,515	306	614	590
$2.00 to $2.24	46,582	1,872	88		708	6	7,061	559	1,535	2,280
$2.25 to $2.49	28,394	714	272		846	1	5,616	311	1,930	1,206
$2.50 to $2.74	25,908	2,749	256	47	960		5,809	395	1,065	1,066
$2.75 to $2.99	13,088	541	265		1,141		1,886	120	656	265
$3.00 to $3.24	10,246	271	189	19	302		2,251	656	599	329
$3.25 to $3.49	6,100	78			150		722	15	244	28
$3.50 to $3.74	4,210						554	31	315	175
$3.75 to $3.99	1,304		45		125		117		20	32
$4.00 to $4.24	398				15		51		33	
$4.25 and over	363				26		81	5	23	
Miners' helpers—										
$0.50 to $0.74	7									
$0.75 to $0.99	184	2	2							1
$1.00 to $1.24	347	15			3		21			5
$1.25 to $1.49	317	56			1		8		34	9
$1.50 to $1.74	608	88		22			14		1	25
$1.75 to $1.99	293				1		3			14
$2.00 to $2.24	561	9	5		15		94	22	5	43
$2.25 to $2.49	311						68		15	7
$2.50 to $2.74	361	3			4		71	10	8	61
$2.75 to $2.99	263				1		118			
$3.00 to $3.24	130				1		100			
$3.25 to $3.49	144						144			
$3.50 to $3.74	1									
Timbermen and track layers—										
$0.50 to $0.74	1								1	
$0.75 to $0.99	27									
$1.00 to $1.24	24	5					1			2
$1.25 to $1.49	209	2				3			1	3
$1.50 to $1.74	640	43			2	2	2		1	4
$1.75 to $1.99	691	12			1	3	18		20	8
$2.00 to $2.24	2,460	9			2		583	2	26	142
$2.25 to $2.49	2,760	12	32		5		684	130	208	16
$2.50 to $2.74	525	84	10		57		45	20	22	1
$2.75 to $2.99	277	18			139		4	5	3	
$3.00 to $3.24	182				105		3		8	
$3.25 to $3.49	7				1					
$3.50 to $3.74	28						3			
$4.25 and over	2						2			
Boys under 16 years—										
Less than $0.50	86	8	1				1			
$0.50 to $0.74	828	53	4				13	1	1	2
$0.75 to $0.99	1,754	241	35				47	58	6	9
$1.00 to $1.24	2,407	165	7	2	67		776	41	118	128
$1.25 to $1.49	332	8			16		64	17		21
$1.50 to $1.74	110				8		10	9		2
$1.75 to $1.99	60	22					1			
$2.00 to $2.24	39	36			3					
$2.25 to $2.49	12	12								
All other wage earners—										
Less than $0.50	2									
$0.50 to $0.74	212	1	1			2	2		3	1
$0.75 to $0.99	395	31	3			5	9	3	2	2
$1.00 to $1.24	2,721	395	33		51	18	75	4	44	18
$1.25 to $1.49	4,659	647	54		21	20	51	88	70	58
$1.50 to $1.74	10,565	692	153		29	7	175	258	106	590
$1.75 to $1.99	9,291	581	60	41	416		1,352	100	241	255
$2.00 to $2.24	17,842	141	192	3	294		3,973	378	255	922
$2.25 to $2.49	9,399	157	207	17	123	4	1,110	267	1,314	128
$2.50 to $2.74	3,347	56	61	1	339		168	92	96	316
$2.75 to $2.99	1,407	38	10		612		17	110	63	3
$3.00 to $3.24	666	7	1		241		25	17	1	4
$3.25 to $3.49	99	1			40		1	15		3
$3.50 to $3.74	51				2		2			
$3.75 to $3.99	6				1					1
$4.00 to $4.24	21		3		1				1	
$4.25 and over	28				23				1	
Average number of wage-earners employed during each month:										
Men 16 years and over—										
January	284,823	12,518	2,826	131	8,015	179	36,730	5,065	10,640	10,719
February	281,380	12,354	2,793	137	8,010	177	36,690	4,918	10,774	10,462
March	277,656	12,458	2,515	133	7,467	162	35,931	4,540	11,449	9,587
April	267,300	12,688	2,357	184	7,275	164	33,524	4,112	9,939	8,068
May	262,358	12,803	2,304	180	7,183	153	32,826	4,054	9,408	7,905
June	257,903	12,661	2,809	181	7,439	154	32,809	4,442	9,618	7,749
July	255,491	10,596	2,524	184	7,295	161	33,424	4,547	9,800	8,182
August	263,693	12,160	2,405	187	7,839	164	33,841	4,614	10,111	8,520
September	273,131	12,566	2,528	187	8,155	162	36,074	4,600	10,606	9,348
October	286,311	12,893	2,576	188	8,567	169	38,381	4,729	11,172	9,873
November	292,891	13,091	2,603	186	8,703	183	38,773	4,974	11,485	10,309
December	297,284	13,056	2,784	185	8,394	188	39,557	5,100	11,614	10,566
Boys under 16 years—										
January	5,714	493	50		95		909	126	122	166
February	5,627	480	51		96		889	124	124	165
March	5,671	458	46	3	88		907	124	125	163
April	5,618	457	37	3	85		892	120	120	158
May	5,648	476	43	3	92		872	119	123	157
June	5,450	484	40	3	95		870	119	122	155
July	5,336	430	47	2	99		862	128	125	162
August	5,480	485	52	2	92		896	130	125	169
September	5,566	485	54	2	90		934	127	126	172
October	5,743	475	44	2	93		959	129	129	170
November	5,827	457	52	2	101		980	135	131	169
December	5,856	436	48	2	105		974	131	128	174

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

	United States.	Alabama.	Arkansas.	California.	Colorado.	Georgia.	Illinois.	Indian Territory.	Indiana.	Iowa.
Contract work:										
Amount paid	$1,244,114	$265,579	$185	$2,900	$14,413	$121,461	$24,689	$56,610	$26,073	$18,046
Number of employees	5,010	1,411	5	19	98	563	152	520	101	240
Miscellaneous expenses.										
Total	$16,774,439	$734,972	$52,949	$8,327	$681,494	$18,319	$1,258,686	$358,950	$449,054	$341,191
Royalties and rent of mine and mining plant	$7,442,069	$149,013	$39,533	$3,000	$228,376	....	$425,705	$244,429	$215,458	$211,275
Rent of offices, taxes, insurance, interest, and other sundries	$9,332,370	$585,959	$13,416	$5,327	$453,118	$18,319	$832,981	$114,521	$233,596	$129,916
Cost of supplies and materials	$24,798,922	$1,219,310	$177,716	$11,930	$1,039,831	$107,994	$2,834,444	$520,664	$739,101	$841,506
Product:										
Quantity, short tons	260,216,844	10,354,570	1,943,932	84,984	7,401,343	414,083	32,939,373	2,820,666	9,446,424	5,904,766
Value	$290,858,483	$12,119,666	$2,539,214	$254,550	$8,397,812	$599,018	$33,945,910	$4,265,106	$10,399,660	$8,660,287
Power										
Total horsepower	521,165	18,979	6,437	1,192	18,663	177	79,182	13,094	23,310	12,253
Owned—										
Engines—										
Steam—										
Number	6,516	279	153	9	258	7	1,212	169	386	258
Horsepower	489,628	18,264	6,432	1,190	16,192	165	78,493	12,709	22,026	11,673
Gas or gasoline—										
Number	152	10	1	1	2	2	14	....	4	31
Horsepower	1,119	86	5	2	7	12	93	....	19	142
Water wheels—										
Number	11	....	....	....	....	....	....	....	....	....
Horsepower	1,384	....	....	....	....	....	....	....	....	....
Other power—										
Number	295	15	....	....	25	....	11	5	13	8
Horsepower	26,675	629	....	....	2,214	....	594	385	1,115	438
Rented—										
Electric, horsepower	2,167	....	....	....	250	....	....	....	....	....
Other power, horsepower	192	....	....	....	....	....	2	....	150	....
Electric motors owned—										
Number	1,325	....	15	15	83	....	102	9	29	14
Horsepower	65,972	....	940	240	3,276	....	4,322	290	2,247	296
Supplied to other establishments, horsepower	1,181	....	....	....	140	....	50	....	100	....

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY,

		Kansas.	Kentucky.	Maryland.	Michigan.	Missouri.	Montana.	New Mexico.	North Dakota.
1	Number of mines	175	523	44	31	384	37	30	47
2	Number of operators	132	503	30	30	345	34	25	47
	Character of ownership:								
3	Individual	73	378	3	5	224	17	10	29
4	Firm	26	32	4	4	73	9	2	9
5	Incorporated company	30	93	23	21	46	8	12	8
6	Other form	3				2		1	1
	Salaried officials, clerks, etc.:								
7	Total number	367	563	210	99	443	61	68	48
8	Total salaries	$345,162	$476,508	$315,791	$87,780	$325,147	$80,674	$85,599	$40,050
	General officers—								
9	Number	35	114	56	10	76	3	4	7
10	Salaries	$71,303	$154,108	$199,400	$19,050	$71,666	$4,200	$12,700	$5,900
	Superintendents, managers, foremen, surveyors, etc.—								
11	Number	76	150	70	27	110	23	27	16
12	Salaries	$88,140	$133,677	$46,788	$26,905	$90,859	$39,728	$39,597	$17,130
	Foremen, below ground—								
13	Number	114	138	47	27	121	13	17	19
14	Salaries	$87,588	$97,650	$35,576	$20,253	$73,721	$15,073	$17,258	$12,580
	Clerks—								
15	Number	142	161	37	35	136	22	20	6
16	Salaries	$98,131	$91,073	$34,027	$21,572	$88,901	$21,673	$16,044	$4,440
	Wage-earners:								
17	Aggregate average number	7,017	9,077	4,936	1,445	6,501	1,587	1,439	287
18	Aggregate wages	$4,719,595	$4,522,207	$3,468,117	$1,075,805	$3,927,158	$1,516,043	$1,027,460	$190,964
	Above ground—								
19	Total average number	780	1,299	568	150	664	257	285	37
20	Total wages	$441,841	$614,447	$308,142	$87,401	$362,857	$230,364	$198,173	$24,745
	Engineers, firemen, and other mechanics—								
21	Average number	278	446	171	78	231	122	133	20
22	Wages	$184,454	$255,717	$110,895	$49,887	$143,006	$118,391	$98,229	$15,940
	Boys under 16 years—								
23	Average number	4	19	22		5		4	
24	Wages	$1,324	$3,334	$5,845		$1,761		$1,234	
	All other wage-earners—								
25	Average number	498	834	375	72	428	135	148	17
26	Wages	$256,063	$355,396	$191,402	$37,514	$218,090	$111,973	$98,710	$8,805
	Below ground—								
27	Total average number	6,237	7,778	4,368	1,295	5,837	1,330	1,154	250
28	Total wages	$4,277,754	$3,907,760	$3,159,975	$988,404	$3,564,301	$1,285,679	$829,287	$166,219
	Miners—								
29	Average number	5,023	5,762	3,560	1,066	4,727	863	944	187
30	Wages	$3,525,812	$3,025,485	$2,738,576	$844,577	$2,927,938	$876,572	$681,905	$125,398
	Miners' helpers—								
31	Average number	25	151		16	71	265	5	
32	Wages	$12,492	$64,768		$9,519	$44,165	$230,024	$3,240	
	Boys under 16 years—								
33	Average number	30	199	107	2	60	9	16	1
34	Wages	$9,043	$41,381	$35,935	$577	$15,740	$3,088	$5,198	$203
	All other wage-earners—								
35	Average number	1,159	1,666	701	211	979	193	189	62
36	Wages	$730,407	$776,126	$385,464	$133,731	$576,457	$175,995	$138,944	$40,618
	Average number of wage-earners at specified daily rates of pay.								
	Engineers—								
37	$0.75 to $0.99								
38	$1.00 to $1.24		3						
39	$1.25 to $1.49		6			1			
40	$1.50 to $1.74	1	13	5		11			
41	$1.75 to $1.99	5	12	7		12			
42	$2.00 to $2.24	25	54	6	1	10		1	1
43	$2.25 to $2.49	25	18	5	1	15			2
44	$2.50 to $2.74	24	6	21	18	7		4	1
45	$2.75 to $2.99	5	1	1		1		11	
46	$3.00 to $3.24	1	2	1			11	15	4
47	$3.25 to $3.49						1	1	
48	$3.50 to $3.74						13	1	
49	$3.75 to $3.99		1				1		1
50	$4.00 to $4.24						8		
51	$4.25 and over	1				1			
	Firemen—								
52	$0.50 to $0.74		1						
53	$0.75 to $0.99	1							
54	$1.00 to $1.24		1	1					
55	$1.25 to $1.49	8	11	1		7	1		
56	$1.50 to $1.74	41	35	8	1	21			
57	$1.75 to $1.99	3	16	5	27	5		1	
58	$2.00 to $2.24	9	15	6	3	9		7	
59	$2.25 to $2.49	2	1	18	1			1	
60	$2.50 to $2.74		2			2	4	10	
61	$2.75 to $2.99						9		2
62	$3.00 to $3.24						17	2	
63	$3.25 to $3.49								
64	$3.50 to $3.74								
	Machinists, blacksmiths, carpenters, and other mechanics—								
65	$0.50 to $0.74					1			
66	$0.75 to $0.99								
67	$1.00 to $1.24	4	1			1			
68	$1.25 to $1.49		14	2			1	36	
69	$1.50 to $1.74	5	46	11	1	8			
70	$1.75 to $1.99	10	55	5	2	2		1	2
71	$2.00 to $2.24	24	84	36	11	30	1	3	1
72	$2.25 to $2.49	89	25	22	2	33		2	
73	$2.50 to $2.74	34	12	5	9	16	8	4	3
74	$2.75 to $2.99	1	2	1			5	2	
75	$3.00 to $3.24	5	4	4		3	13	20	3
76	$3.25 to $3.49	2	1				3	4	
77	$3.50 to $3.74				1	2	16	7	
78	$3.75 to $3.99								
79	$4.00 to $4.24						9		
80	$4.25 and over						1		

BY STATES AND TERRITORIES, 1902—Continued.

Ohio.	Oregon.	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wyoming.	All other states and territories.[1]	
648	9	1,025	84	26	39	26	27	722	36	8	1
513	9	64	73	21	36	22	22	406	22	8	2
204	6	161	12	1	14	3	2	187	5	4	3
127	1	147	10	4	12	8	8	33	5	2	4
179	6	256	50	17	8	11	17	210	12	2	5
1			1								6
1,314	92	1,820	418	93	67	179	200	1,987	126	9	7
$1,222,965	$27,600	$1,142,497	$281,939	$90,098	$80,065	$155,930	$221,925	$1,766,448	$150,153	$7,143	8
185	15	310	79	16	5	17	19	231	17	5	9
$305,226	$8,144	$801,511	$108,933	$31,345	$11,580	$31,180	$27,590	$322,636	$28,722	$3,130	10
411	11	1,230	129	25	16	28	61	618	49	4	11
$444,580	$15,000	$1,186,580	$153,743	$21,441	$20,718	$34,800	$111,255	$647,862	$57,876	$2,145	12
267	5	765	82	22	7	12	52	403	27	2	13
$225,250	$5,400	$872,295	$60,553	$19,588	$8,860	$26,160	$57,404	$381,857	$30,761	$1,450	14
411	3	1,146	128	28	19	92	28	735	42	1	15
$224,958	$2,300	$982,103	$78,618	$28,162	$19,818	$51,712	$20,880	$466,194	$41,821	$400	16
25,962	211	92,000	6,220	1,979	1,576	3,061	3,091	23,912	4,197	46	17
$16,688,464	$144,801	$60,848,962	$3,213,562	$991,391	$1,254,006	$1,407,861	$3,250,255	$13,524,329	$3,207,545	$26,719	18
2,792	12	11,640	835	217	261	260	773	1,077	885	13	19
$1,641,404	$28,103	$6,666,588	$400,088	$87,507	$180,228	$170,144	$552,185	$2,151,900	$660,663	$5,315	20
1,163	20	5,768	251	58	78	200	285	1,418	758	8	21
$751,117	$15,711	$2,842,790	$146,328	$50,377	$66,563	$111,500	$211,519	$906,413	$500,523	$3,565	22
18	6	290	32	8	3	87	30	169	11		23
$8,581	$1,821	$85,624	$7,122	$7,564	$1,332	$6,292	$10,756	$41,303	$1,413		24
1,629	16	7,502	548	133	179	121	188	2,195	511	5	25
$806,478	$10,548	$4,097,981	$246,538	$85,206	$112,333	$58,602	$310,400	$1,204,173	$366,727	$1,810	26
23,171	169	90,445	5,386	1,712	1,315	2,635	2,158	19,887	3,311	33	27
$15,049,008	$116,198	$52,852,514	$2,813,444	$804,084	$1,073,842	$1,328,423	$2,687,778	$11,370,589	$2,426,882	$21,404	28
17,954	116	66,019	3,816	1,402	1,088	1,877	2,346	13,408	2,281	22	29
$12,048,761	$81,061	$44,389,784	$2,101,966	$750,735	$852,006	$888,734	$2,006,580	$8,304,137	$1,861,352	$13,081	30
60		175	446	97		29	54	628	75	7	31
$34,021		$575,821	$109,445	$29,728		$7,762	$37,892	$314,140	$46,655	$4,097	32
318	1	1,417	142	18	10	84	8	180	24		33
$91,178	$340	$893,429	$21,720	$4,362	$3,602	$15,627	$2,102	$168,508	$9,937		34
4,848	52	12,436	983	225	267	685	760	5,161	954	4	35
$2,874,448	$31,757	$7,836,080	$467,324	$110,558	$218,895	$316,300	$951,414	$2,725,890	$608,938	$4,226	36
				3							37
				1							38
2		3	5	5		2		5		2	39
11		18	16	5		1		48			40
46		17	7			6		58	1		41
139		200	14	6	1	4		113	3		42
65		277	9	8		5	9	77	4		43
74	8	188	1		3	6	27	53	24		44
14		80	1		4	3	9	16	4		45
4		18	1	1	2		17	14	20		46
		6			5		4	2	2	1	47
1		3			3		2	1			48
	1										49
		1							1		50
						1					51
											52
				9							53
2		3	1			6		2		3	54
4		21	17	1		9		11			55
25		83	22	2	2	5		92			56
67		169	10	9		71	6	72	1		57
115	3	417	7		1	5	13	48	23		58
14		117			3		23	15	4		59
3	4	76	2		7		21	2	65		60
1		4			5		7		11		61
		[illegible]			2						62
		1									63
		1									64
				2							65
			1	3							66
1		7	2	5		2		10			67
5		20	19	5		88		19		2	68
11		61	32	2		31		70			69
83		115	29	6		24		134	2		70
136		318	33	11		23	7	305	11		71
153		924	11	2	1	13	25	160	52		72
79	4	495	11	5	14	[illegible]	18	77	40		73
51		149			10	4	18	32	27		74
7		87	5		11	6	34	30	57		75
2		2			1	1	9	4	14		76
		6	1				8	5	15		77
		3			1		1	1			78
2		1					2	2	5		79
									2		80

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[1] Includes operators distributed as follows: Alaska, 2; Idaho, 5; North Carolina, 1.

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY,

		Kansas.	Kentucky.	Maryland.	Michigan.	Missouri.	Montana.	New Mexico.	North Dakota.
	Average number of wage-earners at specified daily rates of pay—Continued.								
	Miners—								
81	Less than $0.50		1			19			
82	$0.50 to $0.74		40			16			
83	$0.75 to $0.99	7	241			34			
84	$1.00 to $1.24	29	477		12	87	1		
85	$1.25 to $1.49	143	529	14	52	173		102	1
86	$1.50 to $1.74	129	1,122	83	69	402	1	252	44
87	$1.75 to $1.99	616	886	323	23	1,109	1	35	8
88	$2.00 to $2.24	653	1,164	290	18	1,393	4		47
89	$2.25 to $2.49	1,067	602	1,016	211	562	50	2	28
90	$2.50 to $2.74	836	251	417	105	421		119	56
91	$2.75 to $2.99	1,011	51	855	133	322	1	96	
92	$3.00 to $3.24	120	23	259	341	129	8	307	8
93	$3.25 to $3.49	163	40	35	65	36	117	30	
94	$3.50 to $3.74	49	1	6		24	636	14	
95	$3.75 to $3.99	18	3	209			23	47	
96	$4.00 to $4.24	1	31						
97	$4.25 and over	1		12	47		21	2	
	Miners' helpers—								
98	$0.50 to $0.74		2						
99	$0.75 to $0.99								
100	$1.00 to $1.24	10	27			3			
101	$1.25 to $1.49	1	26			3			
102	$1.50 to $1.74		70					1	
103	$1.75 to $1.99		7		6	40			
104	$2.00 to $2.24	13	19		10	5			
105	$2.25 to $2.49	1							
106	$2.50 to $2.74					20	39	4	
107	$2.75 to $2.99						225		
108	$3.00 to $3.24								
109	$3.25 to $3.49								
110	$3.50 to $3.74						1		
	Timbermen and track layers—								
111	$0.50 to $0.74								
112	$0.75 to $0.99								
113	$1.00 to $1.24	3							
114	$1.25 to $1.49		16			4			
115	$1.50 to $1.74		42	30		2			3
116	$1.75 to $1.99	1	44	16		1			
117	$2.00 to $2.24	6	85	91	63	13		2	
118	$2.25 to $2.49	29	7	33	46	79			2
119	$2.50 to $2.74	1	2	2		11		16	
120	$2.75 to $2.99	9					6	19	6
121	$3.00 to $3.24			2		1	24	11	
122	$3.25 to $3.49					5			
123	$3.50 to $3.74						21		
124	$4.25 and over								
	Boys under 16 years—								
125	Less than $0.50	1	10	2		1			
126	$0.50 to $0.74	1	134	35		14			1
127	$0.75 to $0.99	10	40	31		9		2	
128	$1.00 to $1.24	20	20	11	2	31	9	15	
129	$1.25 to $1.49		12	17		9		2	
130	$1.50 to $1.74		2	9		1		1	
131	$1.75 to $1.99	2		24					
132	$2.00 to $2.24								
133	$2.25 to $2.49								
	All other wage-earners—								
134	Less than $0.50					1			
135	$0.50 to $0.74		29			6			
136	$0.75 to $0.99	1	12	1		14			1
137	$1.00 to $1.24	77	807	19	11	73		2	1
138	$1.25 to $1.49	28	525	17	1	115	2	2	6
139	$1.50 to $1.74	336	513	378	17	236		7	6
140	$1.75 to $1.99	97	699	322	27	174		87	8
141	$2.00 to $2.24	622	88	129	85	474	7	23	19
142	$2.25 to $2.49	229	36	26	31	120	24	29	21
143	$2.50 to $2.74	109	6	9	2	20	85	78	6
144	$2.75 to $2.99	9	3	1		7	38	38	
145	$3.00 to $3.24	24	1			13	102	38	
146	$3.25 to $3.49					8			
147	$3.50 to $3.74	3	1				12	2	
148	$3.75 to $3.99	2	1				1		
149	$4.00 to $4.24						1		
150	$4.25 and over	1					2		
	Average number of wage-earners employed during each month:								
	Men 16 years and over—								
151	January	8,120	9,612	4,830	2,197	7,502	1,579	1,627	395
152	February	7,906	9,265	4,847	2,196	7,323	1,500	1,463	340
153	March	7,294	8,828	4,706	2,198	6,499	1,572	1,482	283
154	April	6,496	8,360	4,734	165	5,976	1,400	1,403	163
155	May	6,199	8,107	4,773	138	6,834	1,481	1,271	149
156	June	6,179	7,713	4,766	131	6,804	1,480	1,421	150
157	July	6,408	7,942	4,793	136	5,798	1,496	1,451	154
158	August	6,512	8,129	4,843	975	5,678	1,492	1,463	178
159	September	6,793	8,621	4,808	2,299	5,905	1,594	1,377	212
160	October	7,284	9,164	4,854	2,253	6,519	1,687	1,410	381
161	November	7,173	9,998	4,881	2,288	6,962	1,727	1,366	491
162	December	7,583	10,296	4,849	2,430	7,322	1,758	1,344	527
	Boys under 16 years—								
163	January	35	219	131	2	69	20	22	1
164	February	35	221	128	2	69	18	18	1
165	March	35	225	129	2	68	10	20	1
166	April	31	219	128		62	9	24	1
167	May	32	211	124		62	8	25	1
168	June	31	207	131		61	8	17	1
169	July	32	234	131	2	59	9	22	1
170	August	32	216	131	2	65	7	19	1
171	September	34	217	129	3	65	5	19	1
172	October	35	218	128	3	65	5	19	1
173	November	38	216	127	4	65	5	18	1
174	December	38	215	131	4	70	4	17	1

BY STATES AND TERRITORIES: 1902—Continued.

Ohio.	Oregon.	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wyoming.	All other states and territories.	
...	...	...	1	...	...	...	...	...	...	...	81
...	...	...	...	...	...	...	...	1	...	...	82
1	...	1	...	...	...	...	...	8	...	...	83
23	1	183	83	71	2	821	...	238	...	...	84
245	...	1,269	308	448	1	116	...	670	...	...	85
2,288	12	7,764	1,013	91	1	199	...	2,208	26	...	86
1,873	...	10,877	944	84	3	118	7	2,395	9	...	87
5,558	58	17,129	667	708	28	412	1	3,448	484	15	88
2,882	1	9,916	352	...	189	193	...	1,738	339	...	89
3,240	...	7,574	118	...	7	...	179	1,481	775	2	90
981	...	3,307	71	...	343	...	381	478	128	...	91
300	40	2,084	219	...	1	1	1,566	459	161	2	92
102	4	3,728	...	...	...	...	124	268	61	...	93
293	...	1,864	...	...	149	7	3	30	29	...	94
55	...	268	...	...	...	...	...	4	248	...	95
23	...	95	...	...	1	...	73	26	11	3	96
95	...	4	...	...	15	...	...	13	20	...	97
...	...	...	5	...	...	...	...	...	...	...	98
...	...	...	110	66	...	...	...	3	...	...	99
5	...	24	147	...	...	21	...	58	...	...	100
8	...	23	72	31	...	8	...	72	...	...	101
9	...	81	64	...	...	...	...	253	...	...	102
32	...	46	9	...	...	...	...	132	...	...	103
3	...	124	38	...	...	...	2	84	33	7	104
11	...	98	...	...	...	...	48	42	21	...	105
...	...	132	...	...	...	...	4	4	1	...	106
...	...	16	...	...	...	...	...	...	...	...	107
...	...	29	...	...	...	...	...	...	...	...	108
...	...	...	...	...	...	...	...	...	...	...	109
...	...	...	...	...	...	...	...	...	...	...	110
...	...	...	...	...	...	...	...	...	...	...	111
...	...	...	...	26	...	...	...	1	...	...	112
...	...	7	3	2	...	...	...	3	...	...	113
1	...	9	20	3	...	60	...	83	...	5	114
10	...	82	63	2	...	65	10	287	...	...	115
51	...	235	34	...	...	9	...	228	10	...	116
264	4	697	27	2	3	71	28	358	2	...	117
245	...	831	6	15	...	9	110	98	5	...	118
16	...	91	2	...	31	...	27	37	44	...	119
...	...	8	...	...	9	...	12	7	2	...	120
8	...	3	...	...	...	...	6	3	5	...	121
...	...	...	...	...	...	...	1	...	...	...	122
...	...	1	...	...	...	...	...	...	...	...	123
...	...	...	...	...	...	...	...	...	...	...	124
2	...	7	22	6	...	14	...	11	...	...	125
14	...	135	113	5	...	69	3	270	...	...	126
106	...	757	37	6	...	22	6	339	...	...	127
207	7	582	1	9	10	15	15	202	7	...	128
6	...	96	1	...	...	...	8	40	12	...	129
8	...	31	...	...	4	...	6	7	12	...	130
3	...	4	...	...	...	...	...	...	4	...	131
...	...	...	...	...	...	...	...	...	...	...	132
...	...	...	...	...	...	...	...	...	...	...	133
...	...	1	...	...	...	...	...	...	...	...	134
11	...	18	53	55	...	...	...	30	...	...	135
70	...	99	17	67	...	31	...	24	...	...	136
185	...	381	288	10	7	55	7	567	3	...	137
151	...	1,009	236	17	4	78	13	1,487	9	...	138
1,299	...	3,344	439	41	18	145	67	1,898	42	...	139
597	...	2,062	138	73	5	175	59	1,541	218	...	140
3,163	64	5,688	89	32	102	31	172	649	247	...	141
212	...	4,162	23	13	22	38	396	185	405	...	142
156	...	993	82	...	182	1	138	84	415	...	143
15	...	250	1	...	45	...	102	22	28	...	144
5	...	70	...	...	20	...	74	7	12	1	145
14	...	5	...	...	...	...	1	11	...	...	146
19	...	10	...	...	...	...	...	...	...	...	147
...	...	...	...	...	...	...	...	...	...	...	148
15	...	2	...	...	...	...	...	1	...	...	149
...	...	...	...	...	...	...	...	...	1	...	150
25,117	213	89,130	6,297	2,020	1,501	2,876	4,232	25,744	4,920	46	151
25,401	213	87,355	6,207	2,035	1,528	2,872	4,196	25,732	4,646	46	152
25,436	203	88,967	6,138	1,954	1,632	2,762	4,183	26,081	4,302	45	153
24,963	199	88,503	6,311	1,956	1,483	2,823	4,055	26,031	3,840	41	154
24,241	192	88,188	6,300	1,988	1,455	2,748	3,610	25,655	3,481	42	155
24,418	193	89,625	6,087	1,984	1,429	2,709	3,617	19,112	3,544	40	156
24,824	188	89,950	5,442	1,978	1,473	2,878	3,750	16,564	3,694	40	157
25,470	198	91,367	5,455	1,950	1,478	2,963	3,683	18,148	3,820	40	158
25,752	203	92,217	5,458	1,913	1,591	2,857	3,719	19,419	4,177	47	159
26,712	211	93,620	5,649	1,887	1,617	2,934	3,885	22,885	4,436	56	160
27,426	216	93,311	6,490	1,891	1,754	3,079	3,857	25,212	4,477	55	161
27,770	219	98,543	6,718	1,891	1,783	3,007	3,920	26,197	4,601	55	162
311	7	1,577	170	26	14	121	38	906	34	...	163
310	7	1,528	169	26	16	118	39	959	34	...	164
322	7	1,577	170	26	13	115	40	965	34	...	165
330	7	1,561	170	26	15	118	39	961	32	...	166
324	7	1,598	172	26	13	117	36	974	35	...	167
332	7	1,617	172	26	16	110	35	758	33	...	168
313	7	1,632	174	26	15	121	33	607	33	...	169
347	7	1,647	179	[illegible]	13	118	35	649	35	...	170
339	7	1,644	179	26	14	133	36	653	36	...	171
354	7	1,641	178	26	11	115	42	845	39	...	172
352	7	1,641	174	26	13	124	42	900	37	...	173
358	7	1,660	181	26	15	130	41	922	38	...	174

TABLE 60.—COAL, BITUMINOUS—DETAILED SUMMARY,

		Kansas.	Kentucky.	Maryland	Michigan.	Missouri.	Montana.	New Mexico.	North Dakota.
	Contract work:								
175	Amount paid	$8,611	$10,068	$8,199	$7,500	$42,031	$1,000	$5,770	$2,795
176	Number of employees	106	73	60	13	110	13	81	9
	Miscellaneous expenses:								
177	Total	$418,921	$285,792	$312,198	$106,414	$250,078	$118,693	$83,990	$22,262
178	Royalties and rent of mine and mining plant.	$173,770	$79,189	$105,607	$48,127	$118,135	$41,153	$26,068	$1,407
179	Rent of offices, taxes, insurance, interest, and other sundries.	$245,151	$206,603	$206,591	$58,287	$131,943	$77,540	$57,922	$20,855
180	Cost of supplies and materials	$706,541	$743,313	$510,092	$82,448	$864,821	$233,930	$156,513	$86,467
	Product								
181	Quantity, short tons	5,266,065	6,766,984	5,271,660	964,718	3,890,151	1,560,928	1,048,763	257,611
182	Value	$6,862,787	$6,666,967	$5,579,869	$1,656,192	$5,371,642	$2,443,447	$1,500,290	$325,967
	Power								
183	Total horsepower	12,620	13,053	9,034	4,466	8,220	5,448	3,879	809
	Owned—								
	Engines—								
	Steam—								
184	Number	222	191	54	46	191	47	57	21
185	Horsepower	12,515	11,881	7,612	3,699	8,184	5,273	3,810	809
	Gas or gasoline—								
186	Number	3	3	3	1	1		1	
187	Horsepower	17	40	12	2	36		25	
	Water wheels—								
188	Number							1	
189	Horsepower							4	
	Other power—								
190	Number	5	16	35	5		20	1	
191	Horsepower	88	982	1,410	765		175	40	
	Rented—								
192	Electric, horsepower		150						
193	Other power, horsepower								
	Electric motors owned—								
194	Number	9	40		12	7	26	12	12
195	Horsepower	270	1,824		376	300	714	1,200	86
196	Supplied to other establishments, horsepower		150						

BY STATES AND TERRITORIES: 1902—Continued.

Ohio.	Oregon.	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wyoming.	All other states and territories.	
$16,818	....	$471,679	$14,094	$38	$340	$27,600	$200	$23,092	$12,747	$1,800	175
200	....	985	71	2	2	32	3	79	17	5	176
$1,619,451	$25,737	$6,178,975	$432,029	$102,237	$94,133	$315,904	$180,213	$2,087,528	$224,947	$1,395	177
$854,604	$1,607	$2,711,816	$247,061	$17,869	$643	$177,199	$40,780	$1,215,940	$83,605	$50	178
$764,847	$24,130	$3,461,159	$187,028	$84,739	$33,180	$158,186	$150,433	$871,588	$161,852	$1,485	179
$2,082,788	$86,355	$8,224,475	$396,561	$99,137	$196,114	$215,468	$473,254	$2,827,377	$669,328	$1,501	180
23,519,894	65,648	98,574,367	1,382,968	991,812	1,574,521	3,182,993	2,681,214	21,570,826	4,429,491	27,242	181
$20,958,789	$160,075	$106,032,160	$5,399,721	$1,477,215	$1,797,184	$2,543,505	$4,372,295	$21,748,658	$5,256,339	$58,728	182
46,635	527	146,921	6,012	1,899	3,197	6,221	10,156	18,674	19,883	155	183
327	11	1,140	66	56	37	52	85	433	152	4	184
45,517	527	134,352	5,678	1,895	3,197	5,846	9,116	44,495	17,283	155	185
28	....	25	13	....	....	....	....	8	....	....	186
188	....	282	94	....	....	....	....	47	....	....	187
....	....	....	....	....	....	3	7	....	....	....	188
....	....	....	....	....	....	375	1,006	....	....	....	189
10	....	81	5	1	....	....	....	18	13	....	190
815	....	10,555	270	4	....	....	....	3,917	2,600	....	191
85	....	1,442	....	....	....	....	25	215	....	....	192
30	....	....	....	....	....	....	10	....	....	....	193
131	....	432	15	1	15	28	77	217	24	....	194
5,527	....	20,508	845	10	1,325	1,280	2,155	16,894	1,079	....	195
....	....	225	....	6	....	315	125	70	....	....	196

PETROLEUM

PETROLEUM.

By F. H. Oliphant.

The only census statistics for the production of crude petroleum comparable with those of 1902 are the statistics for 1870 and 1889. No census of the industry was taken in 1860, the year following the drilling of Drake's well, and the census of 1880 was chiefly for refined petroleum, although some data were given for the crude. In Table 1, which is a comparative summary from 1860 to 1902, the production shown for 1860 is the estimate published by the United States Geological Survey, and the figures for 1880 are selections from tabulations in the census report. However defective the basis of comparison, the table is sufficient to indicate the progress made from one period to another in the rise of this important industry.

Table 1.—*Comparative summary: 1860 to 1902.*

	1902	1889	1880	1870	1860
Number of wells	118,671	35,163	15,092	[1] 2,314	(2)
Number of operators	29,522	(2)	(2)	(2)	(2)
Salaried officials, clerks, etc.:					
Number	3,683	[3] 173	(4)	(4)	(2)
Salaries	$2,986,768	$165,156	(4)	(4)	(2)
Wage-earners:					
Average number	[5] 17,552	[5] 22,366	11,477	4,488	(2)
Wages	$13,242,361	$8,383,744	$7,179,000	$3,925,030	(2)
Contract work	$12,966,631	(2)	$3,730,000	(2)	(2)
Miscellaneous expenses	$15,811,726	(2)	(2)	(2)	(2)
Cost of supplies and materials	$17,781,512	$9,505,935	$3,174,100	$1,401,945	(2)
Product:					
Quantity, barrels of 42 gallons	[6] 89,275,302	35,163,513	26,286,123	4,315,798	500,000
Value	[6] $71,397,739	$26,963,340	$24,600,638	$19,304,224	$4,800,000

[1] Establishments.

[2] Not reported.

[3] Foremen included in wage-earners.

[4] Not reported separately.

[5] The apparent decrease in the wage earners for 1902, as compared with 1889, is caused almost entirely by the difference in the methods of computing the average number at the two censuses.

[6] The United States Geological Survey reports 88,766,916 barrels, valued at $71,178,910, which represents the product marketed. The Census figures represent the petroleum produced.

The statistics showing the production of petroleum in the United States during the decade between the census years 1889 and 1902 indicate a very remarkable increase in the quantity and value of this important natural product. The number of barrels produced in 1889 was 35,163,513, valued at $26,963,340. The number of barrels produced in 1902 was 89,275,302, valued at $71,397,739, which shows an increase of 153.9 per cent in quantity and 164.8 per cent in value. The average increase in quantity for each of the twelve years between the dates named was 12.8 per cent and in value 13.7 per cent. The conditions that brought about this increase were varied and extensive, the most conspicuous of which was the opening up of several large pools in northwestern Pennsylvania during 1890 and 1891, followed by the development of the McDonald pool near Pittsburg, which reached its zenith in 1891, giving to Pennsylvania in that year the greatest production in its record.

In Ohio, from its two fields, there has been a gradual increase, the production reaching its height in 1896, with a slight decline to the close of 1902. In West Virginia, from 1890 to 1900, there was a remarkable increase in the production, the greatest output being in the latter year; this has since been followed by a gradual decline.

In Indiana there have been almost continual gains since the beginning of 1890 to the close of 1902. In California, during the period beginning with 1894 and ending with 1902, there has been a remarkable increase in production, this being most marked from the beginning of 1900 up to the close of 1902. Since the year 1898 the production in Texas has been increasing at a wonderful rate; the gain in 1902 compared with 1901 was the greatest on record. A decided increase was also shown in Kansas.

While the combined output of the older fields in the northeastern portion of the United States showed only a very slight decline, the fields of the Southwest and West developed an extraordinary increase in new production, although this production was of a quality inferior to that of the older fields and was marketed at a less value.

The total number of all wells at the close of 1902, which includes the dry holes and those abandoned, was 118,671; of this number 108,604 were productive wells.

Wells and tankage.—The total number of wells drilled in 1902, both dry holes and productive, the number of flowing and pumping wells, the number of wells operated, the number of wells that produced petroleum and the number abandoned, and the number of tanks at the wells and their capacity for receiving the output are shown in the following table:

TABLE 2.—RECORD OF WELLS AND TANKAGE, BY STATES AND TERRITORIES: 1902.

WELLS AND TANKAGE.	United States.	California.	Colorado.	Indiana.	Kansas.	Kentucky.	New York.	Ohio.	Pennsylvania.	Texas.	West Virginia.	All other states and territories.
Wells:												
Total number	118,671	2,737	111	9,439	470	392	8,443	42,184	40,441	955	15,104	68
Total number producing	108,644	2,574	77	8,224	419	263	8,178	39,056	37,806	852	11,138	[1] 57
Number flowing	694	35		1	52	14	....	3	1	70	500	18
Number pumping	107,950	2,539	77	8,223	367	249	8,178	39,053	37,805	782	10,638	39
Total number drilled during 1902	15,506	425	48	2,932	282	358	626	5,313	3,004	252	2,193	43
Number producing	12,348	323	20	2,489	245	249	531	4,419	2,275	216	1,544	37
Number of dry holes	3,158	102	28	443	37	109	95	894	729	36	649	6
Number abandoned during 1902	6,869	81	6	772	14	20	170	2,533	1,879	67	1,322	5
Tankage:												
Number of tanks at wells	51,774	1,439	60	2,568	394	206	2,937	11,823	20,523	1,010	11,067	37
Total capacity in barrels of 42 gallons	14,415,147	2,366,153	41,570	592,172	43,258	109,989	308,029	1,891,300	1,868,755	4,917,923	2,253,269	16,860

[1] Includes wells distributed as follows: Illinois, 2; Indian Territory, 13; Louisiana, 7; Michigan, 12; Missouri, 5; Oklahoma, 3; Tennessee, 4; Wyoming, 11.

In the entire United States there were 15,506 wells drilled in 1902; of this number 3,158 were dry holes—that is, wells which did not produce petroleum in sufficient quantity to justify pumping them or were totally destitute of petroleum. The number of producing wells drilled in 1902 was, therefore, 12,348. There were 694 flowing wells producing petroleum and 107,950 wells that were pumped, making a total of 108,644 producing wells in the United States in 1902. The greatest number of flowing wells was in West Virginia, where they numbered 500.

Flowing wells do not usually continue to flow for long periods, and are found only in comparatively new territory, where the pressure of natural gas still remains in the rock. Wells that are pumped are usually operated by sucker rods—wooden rods with iron sockets reaching down inside a 2-inch pipe or tubing to a working barrel at the bottom containing valves, the packing being made by leather cups. The motion is from 10 to 18 inches, 20 to 60 strokes per minute. The depth of wells which produce petroleum varies from 250 to 3,300 feet; the latter depth is attained only in West Virginia. Of the total producing wells 70.8 per cent are located in the states of Ohio and Pennsylvania, the former state leading the latter by 1,250 wells. The number of producing wells in New York was 8,178 and in Indiana 8,224. California comes next with 2,574 producing wells, 35 of which are flowing. The number of wells in the United States abandoned during the year was 6,869, which is more than half of the productive wells drilled in 1902. The greatest number of abandoned wells in 1902 was in Ohio, where the number reached 2,533. The number of abandoned wells in Pennsylvania was 1,879; in West Virginia, 1,322; and in Indiana, 772.

The tanks vary in capacity from 5 to 1,200 barrels, and are connected with the pipe line system by pipes. Each tank is usually measured and numbered by the pipe line company and the number of barrels to the inch noted. A valve that is attached to the bottom of the tank and the lead line is locked by the pipe line company and is only opened when the number of inches of petroleum in the tank is measured by the gauger, and it is closed by him at the end of the run.

Capital stock of incorporated companies.—The capital stock and bonded indebtedness of incorporated companies are reported by states and territories in the following table:

TABLE 3.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	California.	Colorado.	Indiana.	Kansas.	Kentucky.
Capital stock and bonds issued	$330,905,859	$109,679,132	$4,840,054	$13,577,400	$6,415,000	$15,248,546
Capital stock:						
Total authorized—						
Number of shares	330,456,514	110,040,309	9,180,000	1,129,814	9,605,000	9,900,100
Par value	$405,904,489	$155,147,989	$7,245,000	$13,981,400	$7,650,000	$19,720,000
Total issued—						
Number of shares	213,116,629	73,218,625	7,116,741	770,564	8,368,000	7,071,811
Par value	$324,186,603	$108,043,132	$4,428,054	$13,577,400	$6,415,000	$15,211,984
Dividends paid	$10,771,936	$1,190,012	$120,042	$1,921,191	$73,500	$84,420
Common—						
Authorized—						
Number of shares	328,039,394	107,646,689	9,180,000	1,129,814	9,605,000	9,900,100
Par value	$404,160,869	$152,754,369	$7,245,000	$13,981,400	$7,650,000	$19,720,000
Issued—						
Number of shares	210,985,678	71,097,964	7,116,741	770,564	8,368,000	7,071,811
Par value	$321,045,942	$105,922,471	$4,428,054	$13,577,400	$6,415,000	$15,211,984
Dividends paid	$10,744,563	$1,186,834	$120,042	$1,921,191	$73,500	$84,420
Preferred—						
Authorized—						
Number of shares	2,417,120	2,393,620	....	....	....	....
Par value	$1,743,620	$2,393,620	....	....	....	....
Issued—						
Number of shares	2,130,951	2,120,661	....	....	....	....
Par value	$3,140,661	$2,120,661	....	....	....	....
Dividends paid	$27,373	$3,178	....	....	....	....
Bonds:						
Authorized—						
Number	162,325	5,300	650	....	....	100,000
Par value	$11,775,000	$5,300,000	$650,000	....	....	$100,000
Issued—						
Number	91,993	1,736	412	....	....	36,562
Par value	$6,719,256	$1,636,000	$412,000	....	....	$36,562
Interest paid	[illegible]	$80,883	$7,840	....	....	$2,066
Assessments levied	[illegible]	$876,198	....	....	....	$410,606

TABLE 3.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902—Continued.

	New York.	Ohio.	Pennsylvania.	Texas.	West Virginia.	All other states and territories.[1]
Capital stock and bonds issued	$1,684,700	$37,358,100	$27,075,100	$79,928,408	$29,706,200	$5,393,219
Capital stock:						
Total authorized—						
Number of shares	16,847	373,581	270,751	152,085,235	415,862	37,441,015
Par value	$1,684,700	$37,358,100	$27,075,100	$99,424,500	$29,706,200	$9,911,500
Total issued—						
Number of shares	16,847	373,581	270,751	108,422,232	415,862	7,071,815
Par value	$1,684,700	$37,358,100	$27,075,100	$75,368,714	$29,706,200	$5,318,219
Dividends paid	$136,015	$4,715,322	$945,372	$655,216	$980,846	
Common—						
Authorized—						
Number of shares	16,847	373,581	270,751	152,061,735	415,862	37,441,015
Par value	$1,684,700	$37,358,100	$27,075,100	$97,074,500	$29,706,200	$9,911,500
Issued—						
Number of shares	16,847	373,581	270,751	108,411,942	415,862	7,071,815
Par value	$1,684,700	$37,358,100	$27,075,100	$74,339,714	$29,706,200	$5,318,219
Dividends paid	$136,015	$4,715,322	$945,372	$631,021	$980,846	
Preferred—						
Authorized—						
Number of shares				23,500		
Par value				$2,350,000		
Issued—						
Number of shares				10,290		
Par value				$1,029,000		
Dividends paid				$24,195		
Bonds:						
Authorized—						
Number				55,975		300
Par value				$5,575,000		$150,000
Issued—						
Number				53,133		150
Par value				$4,559,694		$75,000
Interest paid				$292,050		$4,500
Assessments levied				$178,440		

[1] Includes Illinois, Indian Territory, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming.

The total amount of capital stock issued and funded debt outstanding was $330,905,859. The number of shares of common and preferred stock authorized amounted to 330,456,514. Of this amount 213,116,629 shares were issued, the par value being $324,186,603, upon which $10,771,936, or 3.3 per cent, was paid as dividends. The par value of the common stock issued was $321,036,942 and the dividends paid upon it amounted to $10,744,563; on the issue of preferred stock, the par value of which was $3,149,661, the dividends paid amounted to $27,373. The par value of the bonds issued amounted to $6,719,256 and the interest paid was $297,333, or 4.4 per cent.

The greatest amount of stock was issued in the state of California, the par value being $108,043,132, upon which $1,190,012 in dividends was paid. Texas was next, with a par value of $75,368,714, upon which $655,216 was paid in dividends. Ohio was third; the par value of stock issued amounted to $37,358,100, and the dividends paid, to $4,715,322. In Pennsylvania the par value of stocks was $27,075,100, on which dividends amounting to $945,372 were paid. In West Virginia the par value of the stock issued amounted to $29,706,200 and the dividends to $980,846.

Speculative companies, numbering 1,200 or more, have been organized since 1900, representing a capitalization estimated to be at least $600,000,000. A large amount of stock has been issued by such companies operating in Texas, California, Colorado, Louisiana, and Kentucky.

Employees and wages.—The total number of persons regularly employed in the production of crude petroleum in 1902 was 20,585, who received $16,229,129 in salaries and wages. Of this number 3,033 persons were employed as salaried officials, clerks, etc., and received $2,986,768. The total average number of wage-earners was 17,552, who received $13,242,361. The average number of wage-earners employed each month during 1902 is shown by states and territories in the following table:

TABLE 4.—AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH: 1902.

	United States.	California.	Colorado.	Indiana.	Kansas.	Kentucky.	New York.	Ohio.	Pennsylvania.	Texas.	West Virginia.	All other states and territories.[1]
Men 16 years and over:												
January	17,364	1,094	163	1,381	135	49	410	4,007	5,632	665	3,851	36
February	17,258	1,080	170	1,364	138	49	408	3,973	5,620	606	3,814	36
March	17,346	1,117	151	1,388	136	54	408	3,976	5,620	651	3,800	36
April	17,435	1,105	155	1,428	137	74	409	4,003	5,621	661	3,811	36
May	17,482	1,093	140	1,451	140	73	410	4,009	5,622	698	3,826	39
June	17,364	1,078	157	1,443	143	74	408	4,018	5,585	615	3,799	49
July	17,484	1,090	146	1,464	142	82	407	4,020	5,583	700	3,769	66
August	17,547	1,085	142	1,493	150	87	407	4,030	5,580	735	3,753	76
September	17,506	1,086	146	1,517	149	96	406	4,035	5,566	782	3,729	54
October	17,883	1,138	139	1,541	150	112	407	4,046	5,644	863	3,790	54
November	17,934	1,183	118	1,542	162	106	408	4,046	5,633	875	3,811	72
December	18,103	1,212	137	1,569	164	92	408	4,012	5,643	885	3,829	70

[1] Includes Illinois, Indian Territory, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming.

The greatest number of employees is found in Pennsylvania. Although Ohio, West Virginia, Texas, and California produced more petroleum, they employed fewer wage-earners, because more of their wells were large producers. Pennsylvania employed 32 per cent of the wage-earners and produced only 13.5 per cent of the entire product, the wells with one exception being pumping wells. On the other hand, Texas employed only 4.1 per cent of the wage-earners, although producing 20.7 per cent of the petroleum; and California with 6.3 per cent of the wage-earners yielded 15.7 per cent of the petroleum. There was very little fluctuation in the number employed, taken as a whole.

The average number of wage earners by occupations at specified daily rates of pay is shown in the following table:

TABLE 5.—*Average number of wage-earners at specified daily rates of pay, by occupations: 1902.*

RATE PER DAY (DOLLARS).	All occupations.	Engineers.	Firemen.	Machinists, blacksmiths, carpenters, and other mechanics.	All other wage-earners.
Total	17,552	12,951	75	3,757	779
Less than 0.50	1	1			
0.50 to 0.74	1	1			
0.75 to 0.99	4	2			2
1.00 to 1.24	71	57		12	5
1.25 to 1.49	61	51		1	6
1.50 to 1.74	692	63	1	549	86
1.75 to 1.99	1,078	404		633	41
2.00 to 2.24	1,403	601	5	572	225
2.25 to 2.49	10,046	9,872		138	36
2.50 to 2.74	2,366	1,580	30	502	254
2.75 to 2.99	242	72	8	147	15
3.00 to 3.24	859	182	24	570	83
3.25 to 3.49	277	16	3	258	
3.50 to 3.74	89	25		57	7
3.75 to 3.99	38	1	1	34	2
4.00 to 4.24	25	7		16	2
4.25 and over	289	16	3	265	5

Nearly 57.2 per cent of the wage-earners connected with the production of petroleum in 1902 received between $2.25 and $2.49 per day. Only about eight-tenths of 1 per cent received less than $1.50 per day. Of the 12,951 engineers, 76.2 per cent received between $2.25 and $2.49 per day, and only 1.4 per cent received less than $1.75 per day. Of those rated as mechanics, including blacksmiths, carpenters, and others of like occupation, 63.7 per cent received from $1.50 to $2.74 per day and 19.1 per cent from $2.75 to $3.24. About four-tenths of 1 per cent of this class of wage-earners received less than $1.50 per day. Nearly 84 per cent of "all other wage-earners" received from $1.50 to $2.74 per day.

Contract work.—The amount paid for contract work was $12,956,631, or 44.4 per cent of the total amount paid for salaries, wages, and contract work. Nearly all the building of rigs, drilling of new wells, torpedoing and cleaning out was done by contract work, the cost of which also includes the value of material furnished and a profit to the contractor. There are numerous instances where the owners of wells contracted with individuals for the work necessary to pump and care for a cluster of wells, dividing the pipe line runs pro rata. The entire number thus employed is estimated to be 12,800.

A concise statement covering the entire petroleum producing fields is difficult to secure. The drilling of a well requires from ten days to seven weeks, and, when the work is completed, the crew is removed by the contractor usually to some distant location. A crew is temporarily employed to clean out a well after it has been torpedoed. In torpedoing wells, building tanks, connecting pipe lines, and in other matters of labor and materials furnished which are paid for in the lump, a similar condition of affairs existed, the workmen going from well to well or from district to district. Thus it is that no detailed account can be secured showing what part of the disbursements for this kind of work went to labor under the head of "cost of contract work" and what to "cost of supplies and materials."

Supplies, materials, and miscellaneous expenses.—Under supplies and materials are included casing, tubing, pipe, engines, boilers, tanks, etc., and renewals. Under miscellaneous expenses are included rent of offices, taxes, insurance, etc., and royalties and rent of wells and plants. The entire expense reported under the above headings for the year 1902 was $33,593,238.

Mechanical power.—For the producing wells a total of 910,077 horsepower was reported, of which 907,854 horsepower was owned by the operators and 2,223 horsepower was rented. Of the power owned 666,177 horsepower was furnished by 41,797 steam engines, 240,505 by 12,606 gas or gasoline engines, and 1,172 horsepower by 37 other prime motors. In addition, 2 electric motors with a capacity of 25 horsepower were reported. The steam engines averaged approximately 16 horsepower, and the gas or gasoline engines 19 horsepower. The rented power consisted of 125 electric and 2,098 horsepower of other kinds. The electric power, both owned and rented, was reported from California. Over 54 per cent of the horsepower was employed in Pennsylvania.

Production.—The production of crude petroleum in the United States in 1902 was 89,275,302 barrels—greater than ever before and nearly equal to that of Russia and all the other petroleum producing countries of the world combined. This was the product of 108,644 wells, an average of 822 barrels per well, or 2.14 barrels per well per day. The quantity and value of the crude petroleum produced in the United States in 1902 are given by states and territories, arranged in the order of their production, with percentages of the whole, in the following table

TABLE 6.—*Quantity and value, with percentages, by states and territories: 1902.*

STATE OR TERRITORY.	Barrels.	Per cent.	Value.	Per cent.
Total	89,275,302	100.0	$71,397,739	100.0
Ohio	21,014,231	23.5	20,757,359	29.1
Texas	18,515,017	20.7	4,174,731	5.8
California	13,984,268	15.7	4,873,617	6.8
West Virginia	13,513,345	15.1	17,040,317	23.9
Pennsylvania	12,063,880	13.5	15,266,093	21.4
Indiana	7,480,896	8.4	6,526,622	9.1
New York	1,119,730	1.3	1,530,852	2.1
Louisiana	548,617	0.6	188,985	0.3
Colorado	396,901	0.4	484,683	0.7
Kansas	331,749	0.4	292,464	0.4
Kentucky	248,950	0.3	172,837	0.2
Indian Territory	37,000	0.1	32,190	0.1
Tennessee	12,919	(1)	9,560	(1)
Wyoming	6,253	(1)	43,771	0.1
Michigan	721	(1)	908	(1)
Missouri	525	(1)	1,000	(1)
Illinois	200	(1)	1,000	(1)
Oklahoma	100	(1)	750	(1)

[1] Less than one-tenth of 1 per cent.

Of the total production from 1859 to 1902, Pennsylvania and New York produced 53.9 per cent, Pennsylvania probably producing nearly 50 per cent, and New York about 4 per cent. Ohio produced 24.4 per cent; West Virginia, 11.3 per cent; Indiana, 3.9 per cent; Texas, 2.1 per cent; California, 3.6 per cent; leaving eight-tenths of 1 per cent for the remaining states and territories, which include Colorado, Illinois, Indian Territory, Kansas, Kentucky, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming. It is estimated that from the crude petroleum produced in the United States in 1902, there were obtained 1,938,669,445 gallons of refined petroleum products, which represents about 72 per cent of the total refined products for the world.

In the year 1902 the United States for the first time in five years surpassed the petroleum production of Russia. In that year these two countries together produced 91.4 per cent of the total output, as compared with 93.2 per cent in 1901 and 94.1 per cent in 1900. Indications seem to point to the fact that the wide distribution of petroleum in nearly all countries of the globe, and the more successful methods of securing its profitable production and transportation, will cause an increase in the yearly output of the entire world for a number of years.

The very high grade of a large part of the crude petroleum produced in the United States gives this country a very large percentage of the production of the higher grades of refined petroleum. A careful estimate places the refined product secured from the crude in the United States at 52 per cent of its entire production, compared with 21 per cent of the entire output of Russia and 28 per cent for the average refined products secured from the crude produced in all other countries. It is estimated that the proportion of refined products—the illuminating, naphtha, and lubricating petroleums—produced in the United States in 1902 amounted to 72.1 per cent of the entire production of the world for that year; while Russia produced 25.2 per cent and all the other countries 2.7 per cent. The United States, therefore, produced nearly 2.6 barrels of refined production for every barrel produced by the rest of the world.

The most valuable grades of crude petroleum, from which the very best grades of refined products are secured, continue to be produced in the United States, principally in the northeastern portion, from the Appalachian and Lima-Indiana fields. The lubricating products made from the crude petroleum produced in this section are also superior to any others produced in the entire world. It supplies almost the entire demand for lubricants in the United States, and large quantities of it are marketed abroad. About 45 per cent of the entire quantity of refined petroleum products manufactured in the United States is marketed abroad.

In the following table is given a statement of the total quantity and value of all crude petroleum produced and marketed in the United Stated in 1902 and 1901, by states and territories and important districts, and average price per barrel:

TABLE 7.—*Production, value, and average price per barrel, by states and territories, and by districts: 1902 and 1901.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

STATE, TERRITORY, OR DISTRICT.	1902			1901		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
Grand total	[1] 88,766,916	$71,178,910	$0.8019	69,389,194	$66,417,335	$0.957+
California	13,984,268	4,873,617	0.348	8,786,330	4,974,540	0.566
Colorado	396,901	484,683	1.22	460,520	461,031	1.00
Illinois	200	1,000	5.00	250	1,250	5.00
Indian Territory	37,000	32,190	0.87	10,000	7,125	0.7125
Indiana	7,480,896	6,526,622	0.872	5,757,086	4,822,826	0.8377
Kansas	331,749	292,464	0.88	179,151	151,373	0.862
Kentucky and Tennessee	185,331	141,044	0.76	137,259	111,527	0.813
Louisiana	548,617	188,985	0.344	....	....	....
Michigan Missouri Oklahoma	857	1,816	2.12	2,335	2,600	1.1135
New York	1,119,730	1,530,852	1.367	1,206,618	1,460,008	1.21
Ohio	21,014,231	20,757,359	0.988	21,648,083	20,583,571	0.948
Eastern and southern	5,136,366	6,471,821	1.26	5,470,850	6,619,342	1.21
Lima	15,877,730	14,284,072	0.899	16,176,293	13,911,612	0.86
Mecca-Belden	135	1,466	10.86	940	2,617	2.78
Pennsylvania	12,063,880	15,266,093	1.265	12,625,378	15,430,669	1.222
Franklin	50,555	199,432	3.945	55,162	220,648	4.00
Pennsylvania	12,012,125	15,064,861	1.254	12,568,806	15,208,255	1.21
Smiths Ferry	1,200	1,800	1.50	1,410	1,706	1.21
Texas	18,083,658	3,998,097	0.2211	4,393,658	1,247,351	0.284
West Virginia	13,513,345	17,040,317	1.261	14,177,126	17,172,724	1.211
West Virginia	13,498,685	17,006,469	1.26−	14,164,662	17,139,241	1.21
Petroleum Volcano	[2] 14,660	33,848	2.309	[2] 12,464	33,483	2.687
Wyoming	6,253	43,771	7.00	5,400	37,800	7.00

[1] In addition to this quantity, 76,538 barrels were produced in Kentucky, valued at $41,353; 489 barrels in Missouri, valued at $842; and 431,359 barrels in Texas, valued at $176,634, which were tanked and unsold by the producing companies. These appear in the totals shown in the census tables, making the aggregate 89,275,302 barrels, valued at $71,397,739.

[2] Production of light oil in Petroleum and Volcano included with West Virginia's production.

Petroleum and natural gas.—Petroleum and natural gas are intimately connected in composition and occurrence, one being a gaseous and the other a liquid hydrocarbon, and with but few exceptions they are associated in all of the fields, the gas occupying the upper portion of the same strata which contains the petroleum. In many localities, during cold weather, a small portion of the more volatile naphthas are often condensed from the natural gas and deposited in the pipe lines. Of the combined value of the two, petroleum amounted to a little less than 70 per cent, and natural gas to a little more than 30 per cent.

In combined value they rank next to pig iron and coal in the list of the crude minerals produced in the United States in 1902. The following table presents the combined value of petroleum and natural gas by states and territories in order of values:

TABLE 8.—*Value of petroleum and natural gas: 1902.*

STATE OR TERRITORY.	Total value.	Value of petroleum	Value of natural gas
Total	$102,265,602	$71,397,739	$30,867,863
Pennsylvania	29,618,276	15,266,093	14,352,183
Ohio	23,112,817	20,757,359	2,355,458
West Virginia	22,430,498	17,040,317	5,390,181
Indiana	13,607,966	6,526,622	7,081,344
California	4,994,265	4,873,617	120,648
Texas	4,189,684	4,174,731	14,953
New York	1,877,323	1,530,852	346,471
Kansas	1,116,895	292,464	824,431
Colorado	486,583	484,683	1,900
Kentucky	538,448	172,837	365,611
All other states and territories[1]	292,847	278,164	14,683

[1] Includes Illinois, Indian Territory, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming.

Exports.—Petroleum probably reaches a wider market than any other article in the whole list of our exports. It has penetrated every quarter of the globe and is without a rival in its illuminating and lubricating qualities.

Formerly petroleum was exported in barrels or cans; to-day it is largely transported in bulk, by tank steamers, from which it is delivered to receiving tanks at the various ports. Only from ten to twelve hours are required to receive or discharge a large cargo. From these receiving points it is distributed to tank cars, which reach the inland cities and towns, where it is again delivered to tanks, and finally reaches the consumer by tank wagons. A portion of it for many of the seaport towns in warm climates is still transported in cans.

The tank steamers engaged in the transportation of petroleum are modern ships throughout, and have a number of square iron tanks arranged on each side of the center line. There are a number of bulkheads made double, with water spaces between them, which separate the engine and the boilers and the quarters for the crew from the oil tanks. Some of these tank ships have a capacity of 60,000 barrels, or from 2,500,000 to 2,800,000 gallons.

In 1902 there were exported from the United States 1,064,233,601 gallons of petroleum and its products; this amount was only exceeded in the year 1901, when there were 1,079,074,519 gallons exported.

In 1902, of the total quantity exported from the United States, 50.2 per cent was loaded at New York, which is thus shown to be the leading export city, 32.4 per cent at Philadelphia, 9.2 per cent at points on the Delaware river, and 3.9 per cent at Baltimore. Lately Port Arthur and Sabine City, Tex., have become ports of export, and, together with Boston and Charlestown, Mass., and other districts, whose exports make up the remaining 4.3 per cent of the total.

The first large shipment of petroleum was in 1861, when the brig *Elizabeth Watts*, 224 tons register, sailed from Philadelphia with a full cargo of petroleum in barrels. Doctor Crawford, consul at Antwerp, had received barrels of refined petroleum previous to this shipment. For the year 1862 there were exported from Philadelphia 2,664,280 gallons, followed by 4,680,174 gallons in 1863.

In the following table the production of petroleum in barrels and their equivalent in gallons are given, together with the quantity and value of the total exports; also the quantity in gallons of the crude and manufactured products exported from 1864 to 1902, inclusive.

TABLE 9.—PRODUCTION AND EXPORTS OF CRUDE AND MANUFACTURED PRODUCTS: 1864 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	PRODUCTION.		EXPORTS (GALLONS).						
	Barrels (42 gallons).	Gallons.	Total.		Crude.	Naphtha.	Illuminating.	Lubricating and paraffin.	Residuum.
			Quantity.	Value.					
1864	2,478,709	104,105,778	23,210,369	$10,782,689	9,980,654	138,197	12,791,518		
1865	2,424,905	101,846,010	25,496,849	16,563,413	12,236,857	480,947	12,722,065		
1866	3,165,700	132,959,400	50,987,341	24,830,887	16,052,943	673,477	34,256,921		
1867	3,591,900	150,859,800	70,255,481	24,407,642	7,344,248	224,576	62,686,657		
1868	3,613,709	151,775,778	79,456,888	21,810,676	10,029,670	1,517,268	67,909,964		
1869	4,046,658	169,959,636	100,636,684	31,127,433	13,425,586	2,673,094	84,403,492	134,582	
1870	4,411,016	185,262,672	113,735,294	32,668,960	10,405,314	5,422,604	97,902,505	6,871	
1871	5,205,234	218,619,828	152,195,617	36,063,825	11,278,589	8,396,905	132,178,843	240,228	101,052
1872	6,293,194	264,314,148	144,318,707	33,761,685	16,393,975	8,688,257	118,259,802	438,425	508,218
1873	9,893,786	415,539,012	240,369,908	45,921,880	19,645,740	10,250,197	207,280,988	1,502,503	1,377,180
1874	10,926,945	458,931,690	235,408,168	33,012,276	14,130,851	10,616,641	206,562,977	994,068	2,504,628
1875	12,162,514	510,825,588	237,526,312	31,734,861	16,536,800	14,048,726	203,678,748	938,052	2,323,986
1876	9,132,669	383,572,098	263,449,475	32,545,219	26,343,271	13,252,751	220,841,606	1,157,929	2,863,896
1877	13,350,363	560,715,246	361,883,225	57,548,873	28,773,253	19,565,909	307,378,842	1,914,129	4,276,112
1878	15,396,868	646,668,456	349,346,253	41,022,007	24,019,601	15,431,782	306,212,566	2,525,545	3,186,816
1879	19,914,146	836,394,132	421,719,782	37,235,467	28,641,620	19,624,582	365,597,467	3,168,561	4,827,522
1880	26,286,123	1,104,017,166	346,779,443	34,505,645	36,748,116	15,115,131	286,131,557	5,607,009	3,177,630
1881	27,661,238	1,161,771,996	514,561,719	48,556,105	40,430,108	20,655,136	444,666,615	5,053,862	3,756,018
1882	30,510,830	1,281,454,860	503,492,462	44,623,074	45,011,174	16,949,889	428,424,581	8,821,536	4,265,352
1883	23,449,633	984,884,586	531,145,429	47,763,079	59,018,537	17,366,314	440,140,840	10,108,394	6,502,524

TABLE 9.—PRODUCTION AND EXPORTS OF CRUDE AND MANUFACTURED PRODUCTS: 1864 TO 1902—Continued.

YEAR.	PRODUCTION		EXPORTS—GALLONS						
	Barrels (42 gallons).	Gallons.	Total. Quantity.	Total. Value.	Crude.	Naphtha.	Illuminating.	Lubricating and paraffin.	Residuum.
1884	24,218,438	1,017,174,396	514,405,068	$49,457,116	79,679,395	13,676,421	403,851,275	11,985,219	5,212,758
1885	21,858,785	918,068,970	560,784,159	49,671,743	81,435,609	11,730,409	445,890,518	12,978,955	5,712,968
1886	28,064,841	1,178,723,322	591,881,302	48,145,201	76,346,480	11,674,951	485,130,690	16,218,367	1,999,824
1887	28,283,483	1,187,906,286	601,846,317	46,898,842	80,650,296	12,482,213	485,212,107	20,582,613	2,989,078
1888	27,612,025	1,159,705,050	572,457,975	48,105,703	77,549,432	13,481,706	455,045,784	21,510,437	4,870,616
1889	35,163,513	1,476,867,546	680,705,456	53,293,299	85,189,658	13,984,407	551,769,666	27,903,267	1,858,458
1890	45,822,672	1,924,552,224	693,880,048	52,270,953	96,572,625	12,462,636	550,873,638	32,090,537	1,880,612
1891	54,291,980	2,280,263,160	673,905,577	46,174,845	96,722,807	11,424,993	531,445,099	33,310,261	1,002,414
1892	50,509,136	2,121,383,712	744,638,463	42,729,157	104,897,107	16,893,284	589,418,185	34,026,855	403,032
1893[1]	48,412,666	2,033,331,972	804,221,230	42,142,058	111,703,508	17,304,005	642,239,816	32,432,857	541,044
1894[1]	49,344,516	2,072,469,672	908,252,314	41,499,806	121,926,349	15,555,754	730,368,626	40,190,577	211,008
1895[1]	52,892,276	2,221,475,592	881,502,092	46,660,082	111,285,261	11,801,221	714,859,114	43,418,942	137,508
1896[1]	[2]60,960,361	2,560,335,162	890,458,994	62,383,403	110,923,620	12,349,319	716,455,565	50,525,590	204,900
1897	[2]60,475,516	2,539,971,672	994,297,757	59,057,547	121,188,726	13,730,320	795,919,525	51,228,284	12,230,902
1898	[2]55,364,233	2,325,297,786	982,580,010	52,551,048	111,915,082	17,026,026	761,152,107	63,068,341	29,418,454
1899	[2]57,070,850	2,396,975,700	951,024,441	64,982,249	117,683,967	17,904,015	724,562,993	69,329,188	21,544,278
1900	[3]63,620,529	2,672,062,218	975,123,476	73,276,282	137,501,160	18,262,744	730,585,487	68,997,715	19,776,370
1901	69,389,194	2,914,346,148	1,079,074,519	72,784,912	127,008,002	21,684,734	827,479,493	75,305,938	27,596,352
1902	[4]88,766,916	3,728,210,472	1,064,233,601	68,507,143	145,233,723	19,482,627	778,890,978	82,200,503	38,315,760

[1] Exports are for fiscal years from 1893 to 1896, inclusive.

[2] In addition 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,125 barrels in 1898, and 15,578 barrels in 1899, for which, as none was sold or used, no value could be given.

[3] Includes 11,405 barrels of oil sold in Kentucky and Tennessee in 1900, but produced in previous years.

[4] In addition to this quantity, 508,386 barrels were produced, but not marketed.

Of the total production of crude petroleum in the United States over 38 per cent is exported as crude or refined products, leaving nearly 62 per cent, which is consumed at home. The home consumption has been growing of late, as well as the production of crude petroleum of second quality. As before noted, the total exports, for the first time, exceeded one billion gallons in 1901. There was a slight decline in 1902, yet the amount for the year was still over one billion gallons. The exports of lubricating and paraffin products have for a number of years shown a steady increase.

Foreign markets.—The following table shows the foreign markets for American petroleum and petroleum products for the nine fiscal years ending June 30, 1902:

TABLE 10.—EXPORTS OF PETROLEUM IN ITS VARIOUS FORMS FROM THE UNITED STATES, BY COUNTRIES, FOR THE FISCAL YEARS 1894 TO 1902.

[United States Geological Survey, "The Production of Petroleum," 1902.]

[Gallons.]

COUNTRY AND KIND.	YEAR ENDING JUNE 30—								
	1902	1901	1900	1899	1898	1897	1896	1895	1894
CRUDE									
Total	133,536,800	138,418,430	132,021,650	113,068,060	113,297,397	131,726,243	110,923,620	111,285,264	121,926,349
Europe	114,315,698	126,240,274	118,735,001	101,640,504	101,167,659	118,379,316	98,596,596	98,545,390	106,498,397
France	89,733,092	108,991,721	95,646,840	83,690,510	85,126,667	100,153,929	79,242,152	72,802,470	81,434,953
Germany	6,848,989	4,214,041	3,596,491	3,485,390	3,585,777	2,430,249	817,213	3,966,870	1,877,593
Netherlands	......	......	3,528,761	2,409,040	2,400,000	2,400,000	4,455,460	......	......
Spain	10,132,815	10,229,755	16,127,318	9,723,420	9,914,851	12,049,778	12,869,235	15,188,547	15,176,134
United Kingdom	7,531,278	2,547,501	......	310	5,060	......	......	3,997,013	......
Other Europe	69,584	255,256	138,628	2,391,864	136,314	1,345,360	1,212,528	2,590,441	2,009,727
North America	17,047,967	12,187,081	11,285,875	11,447,556	12,128,712	12,487,307	12,325,724	12,733,994	15,426,042
Mexico	10,844,913	8,356,258	5,002,845	7,998,871	7,713,859	7,090,850	6,779,059	5,229,983	8,026,184
Cuba	6,126,778	3,584,240	5,935,494	3,297,175	3,829,463	4,772,589	4,838,657	6,980,372	6,865,519
Porto Rico	......	......	211,503	160,000	......	......	......	......	......
Other North America	76,276	246,583	136,033	20,510	585,390	623,958	708,008	523,579	534,339
South America: Brazil	......	......	......	......	1,026	841,140	......	......	......
All other countries	2,173,135	21,075	2,780	......	......	18,390	1,300	6,000	2,000
REFINED									
Naphtha	23,498,479	17,851,254	21,998,093	16,262,785	16,202,929	14,249,028	12,349,319	11,801,221	15,555,754
Europe	21,221,988	16,717,472	21,387,003	15,710,221	15,692,796	13,711,520	11,884,216	11,585,121	15,242,221
France	4,381,896	4,146,165	4,776,290	1,517,758	1,713,646	2,103,725	1,672,056	1,561,360	3,761,569
Germany	7,852,196	4,940,546	6,803,632	4,716,800	6,335,309	2,800,883	2,814,217	1,900,028	1,278,757
Netherlands	......	......	2,030,232	1,477,034	1,500	1,400,000	......	......	......
United Kingdom	8,259,392	7,340,907	7,356,748	7,584,536	7,260,140	7,125,371	7,236,285	7,343,355	6,851,760
Other Europe	728,505	290,454	420,706	414,597	382,201	281,541	160,658	577,378	351,135

TABLE 10.—EXPORTS OF PETROLEUM IN ITS VARIOUS FORMS FROM THE UNITED STATES, BY COUNTRIES, FOR THE FISCAL YEARS 1894 TO 1902—Continued.

[Gallons.]

COUNTRY AND KIND.	YEAR ENDING JUNE 30—								
	1902	1901	1900	1899	1898	1897	1896	1895	1894
REFINED—continued.									
Total	2,276,491	1,136,782	606,490	542,761	640,133	557,508	464,103	416,105	313,583
North America	1,269,180	582,756	241,330	251,870	290,072	256,869	308,249	115,950	106,151
West Indies	12,240	318,186	20,479	15,868	18,263	85,720	104,062	81,590	67,195
South America	171,148	116,848	96,314	137,743	85,192	67,178	96,020	135,752	79,777
Asia and Oceania	781,905	215,152	228,228	120,128	231,187	120,479	19,927	45,217	57,037
Africa	42,100	25,061	15,129	16,955	11,521	9,156	7,845	4,865	3,030
Illuminating	842,820,070	781,207,105	721,027,687	732,279,480	821,135,581	771,350,636	716,155,765	714,859,144	730,838,026
Europe	589,282,076	550,143,378	546,651,965	536,913,261	572,103,407	535,987,703	521,060,492	541,238,956	490,252,345
Belgium	43,231,580	41,561,189	43,675,589	40,715,711	44,317,795	42,137,133	35,153,152	35,785,765	30,312,974
Denmark	16,889,651	16,066,127	16,236,065	17,548,051	18,060,052	11,001,735	12,693,927	11,626,436	9,290,251
France	4,379,541	3,022,129	3,962,328	3,094,908	5,975,777	2,736,190	5,348,501	6,201,663	11,812,001
Germany	133,241,233	136,399,456	121,542,723	115,124,570	137,981,137	114,583,356	121,841,246	100,829,413	86,588,786
Italy	21,362,483	21,102,629	17,531,620	19,750,201	18,706,089	21,525,066	22,648,184	28,917,572	22,345,037
Netherlands	130,981,886	127,113,407	121,135,337	138,168,341	131,204,896	126,341,411	122,510,614	45,900,640	51,868,189
Sweden and Norway	31,209,568	27,809,142	24,690,536	17,345,423	23,567,695	18,961,261	10,582,677	21,623,246	9,848,074
United Kingdom	211,228,093	169,548,329	146,477,760	178,796,500	170,160,587	185,200,507	181,885,652	279,064,424	271,555,010
Portugal	3,791,534	1,317,989	1,826,056	2,692,476	5,500,240	1,712,019	1,286,732		
Other Europe	2,963,591	3,362,181	4,567,968	2,787,050	3,821,197	2,488,075	3,862,377	6,586,826	7,232,024
North America	20,836,052	20,084,061	17,586,808	17,066,976	16,480,252	15,552,214	15,716,758	13,231,807	14,152,838
British North America	13,911,744	13,067,191	10,845,114	9,861,600	9,952,286	9,071,814	8,141,864	7,621,352	8,218,137
Central America	857,580	1,024,643	1,102,066	1,075,322	1,034,878	1,201,053	1,371,502		
Mexico	371,421	225,172	282,160	581,222	560,544	345,692	241,061		
West Indies—									
British	2,511,564	2,468,795	2,729,301	2,609,293	2,675,186	2,661,731	2,712,126	4,109,358	4,274,806
Other	3,125,750	3,229,659	2,592,140	2,899,504	2,234,368	2,218,376	2,189,271		
Other North America	57,993	48,636	35,727	30,085	22,020	65,548	60,864	1,501,157	1,759,865
South America	43,730,800	43,951,117	39,930,195	32,306,592	41,956,866	40,173,118	38,760,268	32,435,575	23,341,806
Argentina	9,682,773	10,641,774	10,182,529	6,483,293	10,649,733	9,703,782	7,893,218	5,876,742	3,162,846
Brazil	21,306,538	21,169,678	18,409,626	16,299,130	19,569,447	19,819,161	18,460,043	15,315,196	12,154,709
Chile	4,805,671	4,679,502	4,166,461	3,685,800	3,923,448	3,622,300	4,525,917		
Uruguay	3,346,710	3,067,220	3,120,200	1,760,465	8,576,570	2,821,420	3,622,810	3,898,514	2,320,571
Venezuela	1,179,410	1,409,733	1,021,839	1,327,681	1,417,804	1,456,472	1,483,127		
Other South America	2,809,956	3,092,790	3,029,520	2,760,223	2,820,834	3,049,463	2,784,155	7,245,123	5,703,680
Asia	161,080,240	128,299,535	126,781,665	100,120,865	161,578,868	173,005,081	111,601,908	99,590,684	180,410,123
China	56,702,129	27,419,929	32,775,880	22,683,425	44,324,314	42,516,130	25,604,800	18,022,800	10,377,296
Hongkong	17,920,920	18,768,250	19,181,230	18,095,260	15,637,420	14,977,050	10,450,000	10,595,610	16,888,820
East Indies—									
British	10,364,540	10,712,570	9,906,230	29,109,900	33,311,284	10,270,590	24,762,140	46,680,084	88,961,587
Dutch	15,025,710	17,044,320	11,207,740	15,471,400	12,534,930	24,898,000	16,947,830		
Other East Indies		565,580							
Japan	59,598,671	53,299,686	51,297,805	32,705,180	51,621,050	46,252,501	33,701,038	24,298,270	37,272,490
Other Asia	1,398,200	529,200	2,412,770	155,700	1,119,840	5,085,030			
Oceania	17,129,511	24,388,373	20,788,153	15,469,967	20,734,303	16,343,862	19,283,532	18,322,982	14,766,859
British Australasia	15,131,246	23,136,046	19,542,573	14,396,782	18,859,348	15,324,222	13,721,827	14,686,752	11,821,881
Hawaiian Islands			1,217,780	1,049,210	785,740	391,150	629,740		
Philippine Islands	1,971,100	1,208,100							
Other Oceania	27,165	44,227	27,780	23,575	1,089,215	628,490	4,931,965	3,636,230	2,944,958
Africa	11,170,341	13,867,641	9,288,873	11,372,219	11,563,915	9,988,338	10,280,607	10,133,101	7,378,675
British Africa	9,093,430	10,950,723	8,981,035	7,530,818	5,963,379	4,851,040	10,280,607	9,676,741	7,049,455
Other Africa	2,076,911	2,916,918	1,307,838	3,841,401	5,600,536	5,137,298		456,360	329,220
Lubricating	76,035,611	71,457,605	74,584,769	67,424,393	60,299,365	50,199,345	50,525,520	43,418,942	40,190,574
Europe	60,722,900	55,543,003	60,107,870	53,722,269	50,018,598	41,591,347	43,535,726	37,082,352	35,406,607
Belgium	4,369,691	4,046,434	4,798,917	4,625,800	3,872,617	3,784,941	4,078,951	2,679,842	2,931,294
France	8,146,935	7,321,129	7,170,304	6,500,107	5,246,298	4,225,199	5,165,586	3,271,804	3,050,544
Germany	9,542,846	8,921,513	10,279,660	8,233,910	8,086,774	6,877,196	5,390,561	5,378,398	5,637,471
Italy	2,865,719	1,865,691	2,084,206	1,921,128	1,970,890	1,530,088	1,624,994	1,381,587	1,356,340
Netherlands	5,822,073	4,850,272	5,223,275	4,292,727	4,106,852	2,840,882	2,724,546	2,641,299	2,346,896
United Kingdom	28,084,029	26,762,400	28,669,308	26,373,051	25,724,836	21,301,290	23,436,081	21,299,497	19,668,767
Other Europe	1,891,607	1,875,564	1,882,200	1,775,551	920,919	1,011,201	815,017	520,025	415,395
Total	15,312,711	15,914,602	14,476,899	13,702,116	10,280,767	8,607,998	6,989,794	6,336,590	4,783,967
North America	2,249,658	2,198,465	1,982,313	1,549,299	1,429,468	1,299,249	1,214,588	1,248,751	1,308,586
West Indies	531,613	417,582	308,429	416,680	186,284	114,942	213,304	316,274	417,123
South America	2,442,606	2,292,469	2,488,018	2,899,295	1,971,050	1,876,794	2,221,790	2,159,844	1,509,708
Asia and Oceania	9,344,628	10,413,188	9,244,955	7,737,421	5,978,725	4,879,886	3,000,471	2,438,975	1,433,191
Africa	744,304	603,378	502,184	1,099,421	715,239	477,127	309,701	172,746	115,359
Residuum (barrels)	721,655	622,538	395,933	730,214	175,582	142,612	4,880	3,274	5,029
Europe	710,070	607,778	389,919	724,241	171,604	140,777	4,248	2,099	2,056
North America	10,916	12,873	2,894	5,299	1,680	565	158	1,045	2,460
All other countries	669	1,887	3,120	674	2,278	1,280	194	130	513

The quantities of petroleum and the different petroleum products exported to the several continental groups, Europe, North and South America, Asia and Oceania, and Africa, with percentages for the fiscal year ending June 30, 1902, are shown in the following table:

TABLE 11.—*Exports of petroleum and petroleum products to Europe, North and South America, Asia and Oceania, and Africa, with percentages for the fiscal year ending June 30, 1902.*

[United States Geological Survey, "The Production of Petroleum," 1902.]

[Gallons.]

KIND.	Europe.	North America.	South America.	Asia and Oceania	Africa.
Total	815,365,592	42,405,103	45,973,002	190,508,619	11,956,754
Illuminating	589,282,066	20,836,052	43,330,860	178,209,751	11,170,341
Lubricating	60,722,900	2,781,173	2,442,606	9,344,028	744,304
Naphtha	21,221,988	1,281,439	171,438	781,705	42,109
Residuum[1]	29,822,940	458,472	[2]28,098	....	....
Crude	114,315,698	17,047,967	....	2,173,135	....
Percentage of each	73.7	3.8	4.2	17.2	1.1

[1] In barrels: Europe, 710,070, North America, 10,916; all other countries, 669.

[2] Includes all other countries.

Of the total exportation of all varieties of petroleum during the fiscal year ending June 30, 1902, there was shipped to Europe 73.7 per cent, to Asia and Oceania 17.2 per cent, South America 4.2 per cent, North America 3.8 per cent, and to Africa 1.1 per cent.

Of that portion which went to Europe, exclusive of "residuum," the exports of which are given as 710,070 barrels (or 29,822,940 gallons), the United Kingdom received 32.5 per cent, Germany 20 per cent, the Netherlands 16.1 per cent, France 13.6 per cent, and Norway and Sweden 4 per cent, the remaining 13.8 per cent being divided among Belgium, Denmark, Italy, Portugal, Spain, and the other European countries.

Of the total amount of illuminating oil exported, Japan consumed 7.1 per cent and China and Hongkong 8.9 per cent. These countries consumed over 71 per cent of the total amount exported to Asia and Oceania.

Prices.—The price per gallon of refined petroleum at New York and Philadelphia in 1902, when loaded into bulk steamers, ranged from 4.65 cents to 5.65 cents for oil in bulk; from 7.15 cents to 8.15 cents for oil in barrels; and from 8.40 cents to 10.60 cents for oil in cases; the minimum prices prevailed at the beginning and for the greater part of the year, and the maximum at the close. There was a slight advance in prices in May, June, and July, followed by a decline, and a second advance toward the close of the year.

The average yearly prices in cents per gallon of 70° Abel test refined oil in barrels at New York for the years 1892 to 1902, inclusive, were as follows:

Average yearly prices per gallon of refined petroleum: 1892 to 1902.

YEAR.	Average price (cents per gallon).	YEAR.	Average price (cents per gallon).
1892	6.07	1898	6.32
1893	5.24	1899	7.98
1894	5.19	1900	8.45
1895	7.36	1901	7.48
1896	6.98	1902	7.33
1897	5.91		

The monthly average prices per gallon of crude and refined illuminating petroleum exported in bulk, for the years 1899 to 1902, inclusive, are shown in the following table:

TABLE 12.—*Monthly average prices per gallon of oil exported from the United States in bulk: 1899 to 1902.*

[Cents per gallon.]

MONTH.	1902		1901		1900		1899	
	Mineral, crude.	Refined illuminating	Mineral, crude.	Refined, illuminating.	Mineral crude.	Refined, illuminating.	Mineral, crude.	Refined, illuminating.
January	4.5	6.2	4.7	6.3	6.0	8.4	4.8	4.9
February	4.1	6.3	4.8	6.5	5.9	8.6	4.7	4.9
March	4.5	6.0	5.0	7.1	6.0	8.7	4.7	4.8
April	4.0	6.3	5.1	6.8	6.3	8.6	5.1	4.5
May	4.5	6.5	4.8	6.3	5.8	8.1	4.8	4.5
June	4.8	6.0	4.5	6.1	5.5	7.5	4.6	4.7
July	3.9	6.3	4.5	6.2	4.9	7.0	4.8	5.1
August	4.3	6.1	4.5	6.6	4.9	7.1	4.9	5.3
September	4.3	5.8	4.7	6.4	4.9	7.0	5.1	6.1
October	5.0	6.2	5.0	6.8	4.9	6.3	5.4	6.5
November	4.4	6.6	4.5	6.5	4.9	6.6	5.5	6.9
December	3.9	7.3	5.0	6.4	4.7	6.2	5.9	7.3

PRODUCTION IN THE UNITED STATES SINCE 1859.

The production of crude petroleum in the United States by states, since the commencement of production in 1859, is shown in the following table:

TABLE 13.—PRODUCTION, BY STATES AND TERRITORIES: 1859 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

YEAR.	United States.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.	Kansas.	Texas.	Missouri.	Indian Territory.	Wyoming.	Louisiana.
Total	1,165,290,248	628,401,456	283,751,317	131,701,296	41,831,173	683,212	6,852,926	45,856,215	6,576	1,027,493	24,596,224	5,369	54,554	40,490	548,617
1859	2,000	2,000													
1860	500,000	500,000													
1861	2,113,609	2,113,609													
1862	[1] 3,056,690	3,056,690													
1863	2,611,309	2,611,309													
1864	2,116,109	2,116,109													
1865	2,497,700	2,497,700													
1866	3,597,700	3,597,700													
1867	3,347,300	3,347,300													
1868	3,646,117	3,646,117													
1869	4,215,000	4,215,000													
1870	5,260,745	5,260,745													
1871	5,205,234	5,205,234													
1872	6,293,194	6,293,194													
1873	9,893,786	9,893,786													
1874	10,926,945	10,926,945													
1875	[2] 12,162,514	8,787,514	[3] 200,000	[3] 3,000,000	[3] 175,000										
1876	9,132,669	8,968,906	31,763	120,000	12,000										
1877	13,350,363	13,135,475	29,888	172,000	13,000										
1878	15,396,868	15,163,462	38,179	180,000	15,227										
1879	19,914,146	19,685,176	29,112	180,000	19,858										
1880	26,286,123	26,027,631	38,940	179,000	40,552										
1881	27,661,238	27,376,509	33,867	151,000	99,862										
1882	30,510,830	30,053,500	39,761	128,000	128,636	[4] 160,933									
1883	23,449,633	23,128,389	47,632	126,000	142,857	4,755									
1884	24,218,438	23,772,209	90,081	90,000	262,000	4,148									
1885	21,858,785	20,776,041	661,580	91,000	325,000	5,164									
1886	28,064,841	25,798,000	1,782,970	102,000	377,145	4,726									
1887	28,283,483	22,356,193	5,022,632	145,000	678,572	4,791	76,295								
1888	27,612,025	16,488,668	10,010,868	119,448	690,333	5,096	297,612								
1889	35,163,513	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375	1,460	500	48	20			
1890	45,823,572	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496	900	1,200	54	278			
1891	54,292,655	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675	1,400	54	25	30		
1892	50,509,657	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068	521		45	10	80		
1893	48,431,066	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400	18,000	50	50	10		
1894	49,344,516	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300	40,000	60	8	130	2,369	
1895	52,892,276	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,386,132	200	44,430	50	10	37	3,455	
1896	[5] 60,960,361	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250	113,571	1,450	13	170	2,878	
1897	[5] 60,475,516	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500	81,098	65,975	19	625	3,650	
1898	[5] 55,364,233	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360	71,980	546,070	10		5,475	
1899	[5] 57,070,850	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360	69,700	669,013	132		5,560	
1900	63,620,529	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200	74,714	836,039	[6] 1,602	6,472	5,450	
1901	69,389,194	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250	179,151	4,393,658	[7] 2,335	10,000	5,400	
1902	[8] 88,766,916	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,896	200	331,749	18,083,658	[7] 857	37,000	6,253	548,617

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[1] In addition to this quantity it is estimated that for want of a market some 10,000,000 barrels ran to waste in and prior to 1862 in the Pennsylvania fields; also a large quantity in West Virginia and Tennessee.

[2] Includes all production prior to 1876 in Ohio, West Virginia, and California.

[3] Includes all production prior to 1876.

[4] Includes all petroleum produced in Kentucky and Tennessee prior to 1883.

[5] In addition to this quantity, 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,125 barrels in 1898, and 13,575 barrels in 1899, for which, as none was sold or used, no value could be given.

[6] Includes the production of Michigan.

[7] Includes production of Michigan and small production in Oklahoma.

[8] Does not include 508,386 barrels produced, but not marketed.

Since the year 1888, when the entire production was only 27,612,025 barrels of crude petroleum, there has been on the whole a gradual increase. The year 1891, when the production reached 54,292,655 barrels, had the largest output up to that date, owing chiefly to the increase in Pennsylvania petroleum, caused by the opening up of some wonderfully prolific territory at McDonald, in Allegheny and Washington counties. From 1891 to 1893 there was a considerable decline in the production, the latter year having the smallest output since 1891. After 1894 there was an increase, and the year 1896 showed a larger production than any year up to that date. The figures were not surpassed until 1900, when the production was 63,620,529 barrels. The year 1901 showed substantial gains over 1900, while that of 1902 was nearly 20,000,000 barrels greater than 1901. This increase was due chiefly to the increased production of Texas, California, and Louisiana. The grade of the oil, however, was generally inferior to that of older fields. The production of the high grades of petroleum produced in the Appalachian, Lima-Indiana, Kansas, Corsicana, and the Colorado fields remained about the same as in the previous year. From the output of these fields a superior grade of refined products is manufactured. The poorer grades of petroleum produced in Texas, Louisiana, and California were marketed in 1902, principally for fuel, at much reduced values, although the average price received for the better grades increased about 4 cents per barrel over the average price in 1901.

It will be seen in Table 13 that the production of crude petroleum in the United States from the beginning of the petroleum industry in 1859 to the end of 1902 was 1,165,290,248 barrels. Allowing 5.6 cubic feet for the cubical contents of a barrel of 42 gallons, this quantity would occupy 6,525,625,389 cubic feet and would require a cube 1,869 feet on each side to contain it. It would fill a tank the base of which was 1 mile square to a height of 234 feet. This quantity would fill 38,843 ordinary tanks containing 30,000 barrels; allowing 90 feet for their diameter, if they were placed side by side they would reach a distance of over 662 miles. Again if 2½ feet be taken as the height of a barrel of 42 gallons and if there were sufficient barrels to contain this amount of crude petroleum and the barrels were laid so that their heads would touch, they would encircle the globe 2.27 times. Allowing 3½ barrels to equal the fuel value of a ton of the average coal, the amount represents a fuel value of 332,940,071 tons of coal. There were 301,590,439 tons of coal produced in the United States in the year 1902; the fuel value of the petroleum produced in 1902 would equal that of 25,507,229 tons of coal. The value of the petroleum produced since 1859 to the close of 1902 was $1,166,885,363; the average price was therefore $1.0014 per barrel. The amount invested in wells and fixtures at the end of 1902 is estimated at $290,000,000.

The quantity and value of the crude petroleum produced in the United States for each year since 1859 is shown in Table 14.

TABLE 14.—*Quantity and value of production: 1859 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Barrels (42 gallons).	Value.	YEAR.	Barrels (42 gallons).	Value.
Total.	1,165,290,248	$1,166,885,363	1880	26,286,123	$24,600,638
			1881	27,661,238	23,512,051
1859	2,000	(1)	1882	30,510,830	23,759,911
1860	500,000	1,600,000	1883	23,449,633	25,740,252
1861	2,113,609	1,035,668	1884	24,218,438	20,476,294
1862	[2] 3,056,690	3,209,525	1885	21,858,785	19,193,694
1863	2,611,309	8,225,623	1886	28,064,841	20,028,457
1864	2,116,109	20,896,576	1887	28,283,483	18,856,606
1865	2,497,700	16,459,813	1888	27,612,025	17,950,353
1866	3,597,700	13,455,398	1889	35,163,513	26,963,340
1867	3,347,300	8,066,993	1890	45,823,572	35,365,105
1868	3,646,117	13,217,174	1891	54,292,655	30,526,553
1869	4,215,000	23,730,450	1892	50,509,657	25,906,463
1870	5,260,745	20,503,754	1893	48,431,066	28,932,326
1871	5,205,234	22,591,180	1894	49,344,516	35,522,095
1872	6,293,194	21,440,503	1895	52,892,276	57,691,279
1873	9,893,786	18,100,464	1896	[4] 60,960,361	58,518,709
1874	10,926,945	12,647,527	1897	[4] 60,475,516	40,929,611
1875	[3] 12,162,514	11,963,183	1898	[4] 55,364,233	44,193,359
1876	9,132,669	22,982,822	1899	[4] 57,070,850	64,603,904
1877	13,350,363	31,788,566	1900	63,620,529	75,752,691
1878	15,396,868	18,044,520	1901	69,389,194	66,417,335
1879	19,914,146	17,210,708	1902	[5] 88,766,916	[5] 71,178,910

[1] Value not obtainable.

[2] In addition, it is estimated that for want of a market some 1,000,000 barrels ran to waste in and prior to 1862 in the Pennsylvania fields, also a large quantity in West Virginia and Kentucky.

[3] Includes all production prior to 1876 in Ohio, West Virginia, and California.

[4] In addition, 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,125 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

[5] Does not include 508,386 barrels, valued at $218,829, produced but not marketed.

REVIEW OF THE INDUSTRY BY FIELDS.

The following table shows the production by fields and states for the years 1889 to 1902, inclusive:

TABLE 15.—PRODUCTION, BY FIELDS AND STATES: 1889 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

[Barrels of 42 gallons.]

FIELD.	1902	1901	1900	1899	1898	1897	1896
Total	[1] 88,766,916	69,389,194	[2] 63,620,529	[3] 57,070,850	[3] 55,364,233	[3] 60,475,516	[3] 60,960,361
Appalachian	32,018,787	33,618,171	36,295,433	33,068,356	31,717,425	35,230,271	33,971,902
Lima-Indiana	23,858,626	21,933,379	21,758,750	20,225,356	20,321,323	22,805,033	25,256,870
Southern California	13,984,268	8,786,330	4,324,484	2,642,095	2,257,207	1,903,411	1,252,777
Colorado	396,901	460,520	317,385	390,278	444,383	384,934	361,450
Kansas	331,749	179,151	74,714	69,700	71,980	81,098	113,571
Texas	18,083,658	4,393,658	836,039	669,013	546,070	65,975	1,450
Wyoming	6,253	5,400	5,450	5,560	5,475	3,650	2,878
Louisiana	548,617						
All other	38,057	12,585	8,271	492	370	1,144	463

FIELD.	1895	1894	1893	1892	1891	1890	1889
Total	52,892,276	49,344,516	48,412,666	50,509,971	54,291,980	45,852,638	35,163,513
Appalachian	30,959,139	30,781,921	31,365,890	33,433,212	35,848,777	30,096,516	22,355,225
Lima-Indiana	20,236,741	17,296,510	15,982,097	15,867,575	17,452,612	15,078,378	12,186,564
Southern California	1,208,482	705,969	470,179	385,049	323,600	307,360	303,220
Colorado	438,232	515,746	594,390	824,000	665,482	368,842	316,476
Kansas	44,430	40,000			1,400	1,200	500
Texas	50	60	50	45	54	64	48
Wyoming	3,455	2,369					
Louisiana							
All other	1,747	1,938	60	90	55	278	1,480

[1] Does not include 508,386 barrels produced, but not marketed.

[2] Includes 41,405 barrels of oil sold in Kentucky and Tennessee in 1900, but produced in previous years.

[3] In addition to this total 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,125 barrels in 1898, and 13,678 barrels in 1899, for which, as none was sold or used, no value could be given.

Percentages of production in the Appalachian, Lima-Indiana, and all of the other fields combined for the years 1896 to 1902, inclusive, are as follows:

Per cent of total crude petroleum produced in the several fields: 1896 to 1902.

FIELD.	1902	1901	1900	1899	1898	1897	1896
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Appalachian	36.1	48.5	57.0	58.0	57.3	58.3	55.7
Lima-Indiana	26.3	31.6	34.2	35.4	36.7	37.7	41.4
All other	37.6	19.9	8.8	6.6	6.0	4.0	2.9

During the last three years there has been a constant decline in the proportionate production of crude petroleum in the Appalachian and Lima-Indiana fields, and a very rapid increase in the production of the fields yielding lower grade or fuel oils. In 1896 only 2.9 per cent was produced outside of these two older fields. In 1902 the outside production was 37.6 per cent, of which California produced about 15.7 per cent and Texas 20.4 per cent, leaving only about 1.5 per cent for the remainder of the sections outside the Appalachian and Lima-Indiana fields.

Appalachian field.—This great field follows the northwestern flank of the Appalachian mountains in a generally southwestern direction from New York to Alabama, a distance of about 650 miles. It embraces all the producing regions in New York, Pennsylvania, West Virginia, Kentucky, and Tennessee, and a southeastern portion of Ohio. It includes within its area not less than 40,000 square miles. It is the oldest producing field in the United States.

The first well drilled near Titusville, Pa., in 1859, was followed by a great development which has been succeeded by a vast number of successful operations, extending up to the present time. The great portion of the petroleum output of this field is of a superior quality, and produces a larger proportion of valuable products than any other field in the world. The Appalachian field since its first discovery has produced 72 per cent of the entire output of the United States up to the close of 1902. In 1902 it produced 36.1 per cent of the entire production. The decline of this field has been gradual. The decrease in 1902 was 4.8 per cent, as compared with 7.4 per cent in 1901. The greatest decrease has been in the states of New York, Pennsylvania, and West Virginia. The work in 1902 was confined mostly to the development of the known pools, and no new areas were added to those already known. The southern portion of the field has been recently connected by a large pipe line system, reaching from Parkersburg, W. Va., to Lacy, Pickett county, Tenn., a distance of 270 miles, with several branch lines.

Table 16 shows the production of the several states in this field from 1889 to 1902. It is impossible to completely separate the outputs of New York and Pennsylvania, as some of the fields extend across the boundary, and are thus in both states. The regularity in the output of this field for the last twelve years is noticeable, as shown in the table of total production.

TABLE 16.—*Production of petroleum in the Appalachian oil field, by states: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

YEAR	Total.	Pennsylvania and New York.	West Virginia.	Southeastern Ohio.	Kentucky and Tennessee.
1889	22,355,225	21,487,435	544,113	318,277	5,400
1890	30,073,307	28,458,208	492,578	1,116,521	6,000
1891	35,848,777	33,009,236	2,406,218	424,323	9,000
1892	33,432,577	28,422,377	3,810,086	1,193,414	6,700
1893	31,365,890	20,314,513	8,445,412	2,602,965	3,000
1894	30,783,424	19,019,990	8,577,624	3,184,310	1,500
1895	30,960,639	19,144,390	8,120,125	3,694,624	1,500
1896	33,971,952	20,584,421	10,019,770	3,366,081	1,680
1897	35,230,271	19,262,066	13,090,045	2,877,838	322
1898	31,717,425	15,948,464	13,615,101	2,148,292	5,568
1899	33,068,356	14,374,512	13,910,630	4,764,934	18,280
1900	36,295,433	14,559,127	16,195,675	5,478,372	62,259
1901	33,618,171	13,831,996	14,177,126	5,471,790	137,259
1902	32,018,787	13,183,610	13,513,345	5,136,501	185,331

This table shows a decrease in the production in 1902, as compared with that of 1901, of 1,599,384 barrels, the equivalent of 4.8 per cent, which was greatest proportionally in southeastern Ohio. There were 5,591 productive wells drilled in both 1901 and 1902, and only 31 more dry holes drilled in the latter year than in the former. The only division showing an increase was Kentucky and Tennessee.

The well records for the Appalachian field are shown in Tables 17 and 18.

The total number of dry holes, or those that were destitute of petroleum in paying quantities, in the Appalachian field in 1902 was 2,131. This leaves 5,591 productive wells and shows that 72.4 per cent were productive and 27.6 per cent dry. The number of dry holes drilled in 1901 was 2,118, and there were 5,591 productive wells—the exact number credited to 1902 also. The proportion of productive and dry wells was 72.5 per cent and 27.5 per cent, respectively.

TABLE 17.—TOTAL NUMBER OF WELLS COMPLETED IN THE APPALACHIAN OIL FIELD, BY DISTRICTS: 1892 TO 1902.

[United States Geological Survey "The Production of Petroleum." 1902.]

DISTRICT	WELLS COMPLETED										
	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892
Total	7,722	7,709	8,845	8,752	4,792	6,072	7,824	7,136	3,763	1,980	1,968
Bradford	254	264	404	642	488	696	769	578	284	52	37
Allegany	533	455	575	597	264	350	331	258	82	41	21
Middle	459	490	583	558	388	481	594	401	215	91	151
Venango and Clarion	1,146	1,082	1,494	1,535	772	990	1,614	1,783	731	243	131
Butler and Armstrong	599	534	764	699	497	802	1,153	1,292	755	298	342
Southwest	2,950	3,424	3,598	2,925	2,017	2,255	2,744	2,364	1,481	1,065	1,210
Southeastern Ohio	1,781	1,460	1,427	1,796	366	498	619	460	215	190	76

The wells completed, dry holes, wells productive, initial daily production, wells drilling, and the rigs building in the Appalachian field, by months, during 1902, were as follows:

TABLE 18.—*Well record in the Appalachian oil field: 1902.*

[United States Geological Survey, "Mineral Resources of the United States." 1902.]

MONTH.	Wells completed.	Dry holes.	Wells productive.	Initial production.[1]	Wells drilling.	Rigs building.
Total	7,722	2,131	5,591	[2] 7,099	[2] 600	[2] 334
January	582	169	413	6,008	622	337
February	455	132	323	4,233	570	335
March	514	158	356	6,366	572	323
April	579	186	393	6,140	580	312
May	648	161	487	6,668	611	307
June	745	214	531	7,348	590	323
July	685	166	519	7,753	592	304
August	725	149	576	7,725	621	331
September	730	194	536	9,866	624	368
October	713	176	537	9,090	617	352
November	729	209	520	8,900	634	377
December	617	217	400	5,090	582	343

[1] Barrels of 42 gallons. [2] Average.

Appalachian, Lima-Indiana, and all other fields.—Table 19 gives the production of the Appalachian, Lima-Indiana, and all other fields from 1896 to 1902, by years, and the percentage each is of the total. It also gives the average value of the production by years and the average price per barrel at which it was marketed.

One of the interesting conditions revealed is the regularity of the combined production of the Appalachian and the Lima-Indiana fields for the last five or six years; another is the very remarkable increase in the combined production of all other fields, which in 1896 amounted to but 2.84 per cent of the whole, but which was increased to 19.94 per cent in 1901, and to 37.62 per cent in 1902. The value of the petroleum and natural gas marketed in 1902 was greater than in previous years. In 1900 there was the largest production of higher priced grades of petroleum.

The value of natural gas marketed during the several years and the combined value of petroleum and natural gas are also given, for the reason that they are so intimately associated.

The largest production of natural lubricating petroleum is from the Franklin district, Pa. The other districts in the United States which produce natural lubricating petroleum are Petroleum and Volcano, in West Virginia; Mecca and Belden, in Ohio; and Salt Creek, in Wyoming. In 1902 the entire production amounted to 71,603 barrels, valued at $278,517.

TABLE 19.—PRODUCTION OF PETROLEUM IN THE APPALACHIAN, LIMA-INDIANA, AND ALL OTHER FIELDS, PERCENTAGES OF EACH, VALUE PER BARREL, AND THE VALUE OF PETROLEUM AND NATURAL GAS, SEPARATE AND COMBINED: 1896 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

[Barrels of 42 gallons.]

FIELD.	1902		1901		1900		1899		1898		1897		1896	
	Production.	Per cent.	Production.	Per cent.	Production.	Per cent.	Production.	Per cent.	Production.	Per cent.	Production.	Per cent.	Production.	Per cent.
Total	88,766,916	100.00	69,389,194	100.00	63,620,529	100.00	[1] 57,070,850	100.00	[1] 55,364,233	100.00	[1] 60,475,516	100.00	[1] 60,960,361	100.00
Sum of both fields	55,377,413	62.38	55,551,550	80.06	58,054,183	91.25	53,293,712	93.38	52,038,748	93.99	58,035,304	96.97	59,227,772	97.16
Appalachian	32,018,787	36.07	33,618,171	48.45	36,295,433	57.05	33,068,356	57.94	31,717,425	57.29	35,230,271	58.26	33,971,902	55.73
Lima-Indiana	23,358,626	26.31	21,933,379	31.61	21,758,750	34.20	20,225,356	35.44	20,321,323	36.70	22,805,033	37.71	25,255,870	41.43
All other	33,389,503	37.62	13,837,644	19.94	5,566,346	8.75	3,777,138	6.62	3,325,485	6.01	2,440,212	4.03	1,732,589	2.84
	Gross value.	Value per barrel.	Gross value.	Value per barrel.	Gross value.	Value per barrel.	Gross value.	Value per barrel.	Gross value.	Value per barrel.	Gross value.	Value per barrel.	Gross value.	Value per barrel.
Total	$102,046,578	......	$93,483,412	......	$99,451,365	......	$84,678,777	......	$59,490,372	......	$54,756,033	......	$71,521,221	......
Value of petroleum	[2] 71,178,910	$0.802	66,417,335	$0.957	75,752,691	$1.191	64,603,904	$1.132	44,193,559	$0.798	40,929,611	$0.677	58,518,709	$0.959
Value of natural gas	30,867,668	......	27,066,077	......	23,698,674	......	20,074,873	......	15,296,813	......	13,826,422	......	13,002,512	......

[1] In addition to these quantities, 1,325 barrels were produced in Kentucky and Tennessee in 1896, 1,377 barrels in 1897, 19,125 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

[2] Does not include $218,829, the value of product not marketed.

The following table gives the production and value of lubricating petroleum in the several districts in Pennsylvania, West Virginia, Ohio, and Wyoming from 1896 to 1902, inclusive:

TABLE 20.—PRODUCTION AND VALUE OF NATURAL LUBRICATING PETROLEUM, BY STATES AND DISTRICTS: 1896 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

STATE AND DISTRICT.	1902		1901		1900		1899		1898		1897		1896	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
Total	71,603	$278,517	73,966	$294,548	82,687	$329,435	85,159	$322,523	74,212	$296,804	65,209	$255,432	66,677	$258,323
Pennsylvania: Franklin district	50,555	199,432	55,162	220,648	59,036	236,144	61,085	241,540	56,090	224,360	48,880	195,520	49,522	197,316
West Virginia: Petroleum and Volcano districts	14,660	33,848	12,464	33,483	15,918	43,638	17,721	40,819	11,965	30,501	12,004	27,592	13,804	35,086
Ohio: Mecca and Belden districts	135	1,466	940	2,617	2,283	11,503	793	1,244	682	3,618	645	3,120	473	2,897
Wyoming: Salt Creek district	6,253	43,771	5,400	37,800	5,450	38,150	5,560	38,920	5,475	38,325	3,680	29,200	2,878	23,024

The value of the lubricating petroleum produced in Wyoming has for several years been $7 per barrel. The general character of the natural lubricating petroleum produced in West Virginia is similar to that produced at Franklin, Pennsylvania.

The production of the Franklin district for 1902 was 50,555 barrels, which was less than that of 1901 by 4,607 barrels.

There has been a gradual decline in this field since 1899, when the total yield was 61,085 barrels. The price received in 1902—$3.94—was slightly less than in 1901, when it was $4.

The following group of tables gives the runs or receipts, the shipments or deliveries, and the stocks of crude petroleum reported by the pipe lines in the Appalachian and Lima-Indiana fields for a series of years. Table 21 gives, in detail, the pipe line runs in the Appalachian field from 1888 to 1902, inclusive, and Table 22 the totals of the pipe line runs in the Appalachian and Lima-Indiana fields.

Table 23 shows the shipments in the Appalachian and Lima-Indiana fields, and Table 24 the stocks of petroleum in the same for the years 1894 to 1902, inclusive.

TABLE 21.—PIPE LINE RUNS IN THE APPALACHIAN FIELD, IN DETAIL: 1888 TO 1902.

[United States Geological Survey, "The Production of Petroleum," 1902.]

[Barrels of 42 gallons.]

YEAR.	Total.	National Transit.	Tide Water.	Octave.	Pittsburg.	Southwest.	Franklin.	Western and Atlantic.	Charles Miller.
1888	16,366,664	11,745,081	1,389,599	25,672	341,618	1,845,070	76,512	842,890	99,525
1889	22,029,729	15,675,776	1,595,904	32,836		2,734,519	65,244	2,501,826	88,113
1890	21,196,543	15,407,552	1,827,798	38,100		7,565,743	67,788	3,109,477	100,571
1891	34,876,266	11,046,171	1,777,875	38,827		13,517,894	65,185	2,178,213	143,701
1892	32,749,562	11,362,578	1,458,462	30,137		10,829,256	58,459	1,442,160	68,888
1893	31,003,260	8,037,337	1,579,586	23,148		5,730,856	66,278	1,019,849	26,724
1894	30,117,096	8,218,016	1,751,897	30,629		5,530,335	57,070	48,117	
1895	30,351,414	8,853,706	1,814,655	....		5,253,378	48,711		
1896	33,505,197	9,476,112	1,903,140	....		6,666,314	49,329		
1897	34,773,965	9,807,620	1,822,480	....		5,329,338	48,880		
1898	31,156,440	7,953,222	1,561,568			4,143,468	56,090		
1899	32,260,689	6,886,267	1,565,611			5,426,311	53,278		
1900	35,540,964	6,859,801	1,675,225			7,716,139	51,406		
1901	33,091,120	6,207,595	1,445,530			4,948,882	58,107		
1902	31,404,187	5,788,322	1,302,568			5,167,729	41,709		

YEAR.	Eureka.	Elk.	Emery.	Mellon.	Cumberland.	United States.	Producers and Refiners' Pipe Line Company (Limited).	Buckeye Macksburg Division.
1888	....						.....	40,288
1889								238,776
1890								1,021,613
1891	2,184,413	257,396	176,876	340,086				877,232
1892	5,606,066	324,219	324,158	1,816,265			550,079	1,117,147
1893	7,551,806	280,870	371,068	3,109,915			1,113,158	2,075,115
1894	7,254,215	218,874	379,466	2,528,832			1,196,849	2,962,703
1895	7,513,251	243,889	390,665	1,985,376			1,351,372	2,964,475
1896	9,985,201	283,741	322,680				1,392,170	3,338,176
1897	13,008,341	227,817	318,074				1,316,400	2,893,735
1898	13,758,409	191,229	311,398				1,270,291	2,158,071
1899	13,765,761	186,314	292,040				1,313,436	4,628,706
1900	16,114,588	192,352	333,154			32,573	1,321,013	4,254,214
1901	14,114,728	170,280	311,185		141,419	53,722	1,210,457	5,311,239
1902	15,011,859	162,700	317,935		188,620	72,717	1,219,956	5,064,991

TABLE 22.—TOTALS OF PIPE LINE RUNS IN THE APPALACHIAN AND LIMA-INDIANA FIELDS: 1888 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

YEAR.	Total.	Appalachian.	Lima-Indiana.	YEAR.	Total.	Appalachian.	Lima-Indiana.
1888	25,265,668	16,366,664	8,899,004	1896	55,715,208	33,505,197	22,210,011
1889	32,285,451	22,029,729	10,255,722	1897	54,444,077	34,773,563	19,670,514
1890	33,115,453	21,196,543	11,918,910	1898	48,285,346	31,156,449	17,128,897
1891	49,392,036	34,876,266	14,515,770	1899	49,444,493	32,260,689	17,183,804
1892	46,317,299	32,749,562	13,567,737	1900	53,771,543	35,540,964	18,230,579
1893	45,454,455	31,003,260	14,451,195	1901	51,661,890	33,091,120	18,570,770
1894	46,191,446	30,117,096	16,074,350	1902	51,388,553	31,404,187	19,984,366
1895	48,767,144	30,351,514	18,415,630				

TABLE 23.—SHIPMENTS IN THE APPALACHIAN AND LIMA-INDIANA FIELDS: 1894 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

FIELD.	1902	1901	1900	1899	1898	1897	1896	1895	1894
Total	57,283,160	54,242,241	51,218,694	51,946,942	54,858,356	53,756,750	49,361,601	48,862,992	50,661,037
Appalachian	35,192,689	36,481,726	35,401,113	30,317,426	30,405,936	33,664,324	29,340,135	32,002,626	36,207,275
Lima-Indiana	22,090,471	17,760,515	15,817,581	21,629,516	24,452,420	20,092,426	20,021,466	16,860,366	14,453,762

TABLE 24.—STOCKS OF PETROLEUM IN THE APPALACHIAN AND LIMA-INDIANA FIELDS AT THE CLOSE OF THE YEAR: 1894 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

FIELD.	1902	1901	1900	1899	1898	1897	1896	1895	1894
Total	23,048,050	27,395,798	28,464,476	23,997,118	26,967,495	33,772,823	33,048,492	26,839,632	26,658,146
Appalachian	5,741,624	9,635,492	13,475,548	13,451,191	11,786,603	11,010,044	9,745,722	5,344,784	6,499,880
Lima-Indiana	17,306,426	17,760,306	14,988,928	10,545,927	15,180,892	22,762,779	23,302,770	21,494,848	20,158,266

The fields in Kansas, Texas, and California and elsewhere are not so well supplied by pipe line companies, and the petroleum is transported mostly by private pipe lines, often owned by the producing company.

It will be seen from the preceding tables that for the year 1902 the combined runs for the Appalachian and Lima-Indiana fields were 51,388,553 barrels, which amount does not vary greatly from the average for the past eight years, though a slight decline was recorded in 1902 as compared with 1901. There are some few deliveries to refineries direct from the field and some petroleum loaded in tank cars that are not included in the pipe line reports.

The shipments which represent the deliveries from both these fields to the refineries and other consumers were quite large in 1902, amounting to 57,283,160 barrels, an increase of 3,040,919 barrels over those of 1901. As the shipments were larger than the production, the increase was made up from the stocks which had been accumulated by the pipe line companies.

The Appalachian and Lima-Indiana stocks on hand at the close of 1902 amounted to 23,048,050 barrels, showing a decrease for these fields of 4,347,748 barrels as compared with the amount at the close of 1901. These stocks are stored in large iron tanks at a number of localities, generally near the pumping stations of the main pipe lines.

The stocks in the fields are held principally by the large pipe line companies, who have, in nearly all cases, purchased the crude petroleum. There is also a varying amount of stock held by the original producers at their wells.

In the states of Texas and California, besides the stock in the hands of the producers and refiners, there are a number of individuals, companies, and railroads who own their tankage. The estimated stock in these and other states and territories, as well as in the Appalachian and Lima-Indiana fields, is shown in the following table:

TABLE 25.—*Stocks of petroleum held in the several fields, states, and territories at the close of 1902, 1901, and 1900.*

[Barrels of 42 gallons.]

FIELD.	1902	1901	1900
Total	36,168,050	32,090,798	29,350,476
Stocks in the Appalachian field[1]	5,741,624	9,635,492	13,475,548
Stocks in the Lima-Indiana field[2]	17,306,426	17,760,306	14,988,928
Stocks in Kansas (estimated)	210,000	70,000	60,000
Stocks in Colorado (estimated)	100,000	80,000	60,000
Stocks in Texas (estimated)	7,650,000	1,725,000	6,000
Stocks in California (estimated)	4,800,000	2,800,000	750,000
Stocks in Louisiana (estimated)	320,000	....	....
Stocks in all other states and territories[3]	40,000	20,000	10,000

[1] The Appalachian field includes New York, Pennsylvania, West Virginia, Kentucky, Tennessee, and the southeastern portion of Ohio.

[2] The Lima-Indiana field includes Indiana and northwestern Ohio.

[3] Includes Indian Territory, Oklahoma, Wyoming, Michigan, Missouri, and Illinois.

Stocks of Pennsylvania or Appalachian crude petroleum have decreased since the close of 1891. In that year there were 16,457,089 barrels of what is known as Pennsylvania oil, held in tanks, principally in Pennsylvania, and smaller amounts in West Virginia and Ohio, as compared with 5,741,624 barrels held at the close of 1902. In the Lima-Indiana field there were 22,103,705 barrels, principally in Ohio, making a total stock for the two fields of 38,560,794 barrels in 1891, as compared with 23,048,050 barrels at the close of 1902. Of the latter amount 5,741,624 barrels were Appalachian petroleum and 17,306,426 barrels Lima-Indiana petroleum. The success in refining the petroleum from the Lima-Indiana field has greatly increased the production of the higher grade of illuminating petroleum and enabled the refiners to supply their home consumers and furnish an increasing quantity for the export trade.

The following table gives the average yearly price of all the grades of petroleum from 1889 to 1902:

Table 26.—*Average yearly price of all the petroleum produced: 1889 to 1902.*

[Barrels of 42 gallons.]

YEAR.	Average price (cents).	YEAR.	Average price (cents).
1889	76.62	1896	95.90
1890	77.17	1897	67.70
1891	56.25	1898	79.80
1892	51.33	1899	113.20
1893	59.75	1900	119.10
1894	72.00	1901	95.70
1895	108.88	1902	80.20

The average prices shown in the following table cover the ordinary grades of petroleum. They do not include special oils, such as the lubricating oils from the Franklin district, nor those from the Petroleum and Volcano districts of West Virginia, nor those from the Mecca-Belden district of Ohio, but only those, such as Pennsylvania oil, used chiefly for the production of illuminants.

Table 27.—*Range of prices paid for petroleum in the Appalachian oil region by the Seep Purchasing Agency during 1902.*

[Barrels of 42 gallons.]

DATE.	Tiona.	Pennsylvania.	Corning.	Newcastle.
January 1	$1.30	$1.15	$0.98	$0.90
April 16	1.35	1.20	1.03	0.95
June 26	1.37	1.22	1.05	0.97
October 4	1.40	1.25	1.08	1.00
October 7	1.42	1.27	1.10	1.02
October 16	1.45	1.30	1.13	1.05
October 29	1.48	1.33	1.16	1.08
November 6	1.51	1.36	1.19	1.11
November 11	1.54	1.39	1.22	1.14
November 25	1.57	1.42	1.25	1.17
December 4	1.60	1.45	1.28	1.20
December 6	1.63	1.48	1.28	1.35
December 12	1.66	1.51	1.31	1.38
December 31	1.69	1.54	1.34	1.41

In some of the districts oil is worth more than ordinary Pennsylvania oil, and in some districts it is worth less. This is owing to the fact that the production of some districts furnishes a larger percentage of illuminating oil and of by-products. Petroleum that has remained in tanks at the wells for a long period loses a percentage of its illuminating properties and is worth less than what is known as fresh oil, or petroleum recently produced at the wells.

The great volume of trade is controlled by the prices under the name of Pennsylvania oil, which includes nearly all the oil sold in New York, nearly all of that sold in Pennsylvania and West Virginia, and a large proportion of the ordinary Appalachian petroleum sold in Ohio.

In the following table are given the average monthly prices during 1901 and 1902 of crude petroleum produced in the various districts of the Appalachian oil regions in which special prices are paid. It is considered that the bulk of the crude petroleum is sold at prices slightly greater than the average price per month.

Table 28.—*Average monthly prices of Appalachian crude petroleum: 1902 and 1901.*

[Barrels of 42 gallons.]

MONTH.	1902				1901			
	Tiona.	Pennsylvania.	Corning.	Newcastle.	Tiona.	Pennsylvania.	Corning.	Newcastle.
January	$1.30	$1.15	$0.98	$0.90	$1.34¼	$1.19¼	$1.02¼	$0.94¼
February	1.30	1.15	0.98	0.90	1.40	1.25	1.08	1.00
March	1.30	1.15	0.98	0.90	1.44	1.29	1.12	1.04
April	1.32¾	1.17¾	1.00¾	0.92¾	1.35¼	1.20¼	1.03¼	0.95¼
May	1.35	1.20	1.03	0.95	1.22¾	1.07¾	0.90¾	0.82¾
June	1.35¼	1.20¼	1.03¼	0.95¼	1.20	1.05	0.88	0.80
July	1.37	1.22	1.05	0.97	1.28¼	1.13¼	0.96¼	0.88¼
August	1.37	1.22	1.05	0.97	1.40	1.25	1.08	1.00
September	1.37	1.22	1.05	0.97	1.40¼	1.25¼	1.08¼	1.00¼
October	1.43½	1.28½	1.11½	1.03½	1.45	1.30	1.13	1.05
November	1.53½	1.38½	1.21½	1.13½	1.45	1.30	1.13	1.05
December	1.64	1.49	1.29¼	1.33¼	1.36	1.21	1.04	0.96
Average	1.38¾	1.23¾	1.06¾	0.99¾	1.36	1.21	1.04	0.96

The average monthly prices of Lima (Ohio) and Indiana crude petroleum, per barrel of 42 gallons each, in the years 1902 and 1901 were as follows:

Table 29.—*Average monthly prices of Ohio and Indiana crude petroleum: 1902 and 1901.*

[Barrels of 42 gallons.]

MONTH.	1902			1901		
	North Lima.	South Lima.	Indiana.	North Lima.	South Lima.	Indiana.
January	$0.85	$0.80	$0.80	$0.87½	$0.82½	$0.82½
February	0.85	0.80	0.80	0.91	0.86	0.86
March	0.85	0.80	0.80	0.93½	0.88½	0.88½
April	0.86½	0.81½	0.81½	0.88½	0.83½	0.83½
May	0.88	0.83	0.83	0.80½	0.75½	0.75½
June	0.88¼	0.83¼	0.83¼	0.79	0.74	0.74
July	0.89	0.84	0.84	0.84	0.79	0.79
August	0.89	0.84	0.84	0.91	0.86	0.86
September	0.89	0.84	0.84	0.91½	0.86½	0.86½
October	0.93½	0.88½	0.88½	0.94	0.89	0.89
November	1.00¼	0.95¼	0.95¼	0.94	0.89	0.89
December	1.10	1.05	1.05	0.88½	0.83½	0.83½
Average	0.90¼	0.85¼	0.85¼	0.88¾	0.83¾	0.83¾
Average of North and South Lima	0.88¼			0.86		

The North Lima is separated from the South Lima field by an east-and-west line passing through the southern portion of the town of Fostoria, Ohio. This division is made owing to the lighter gravity of North Lima petroleum and the larger percentage of the more valuable products secured from it. The production of the Indiana field is of the same grade as the South Lima petroleum and commands the same price.

In the following table there is shown the fluctuations in prices for the various grades of Lima oil in 1902. The dates are those on which changes in prices were made.

TABLE 30.—*Fluctuations in prices of Lima (Ohio) and Indiana crude petroleum: 1902.*

DATE.	North Lima.	South Lima.	Indiana.
January 1	$0.85	$0.80	$0.80
April 16	0.88	0.83	0.83
June 26	0.89	0.84	0.84
October 4	0.91	0.86	0.86
October 7	0.92	0.87	0.87
October 16	0.95	0.90	0.90
October 29	0.97	0.92	0.92
November 6	0.99	0.94	0.94
November 11	1.01	0.96	0.96
November 25	1.03	0.98	0.98
December 4	1.06	1.01	1.01
December 8	1.09	1.04	1.04
December 12	1.12	1.07	1.07
December 31	1.15	1.10	1.10

The highest, lowest, and average prices of Lima (Ohio) oil for the last sixteen years have been as follows:

TABLE 31.—*Highest, lowest, and average prices of Lima (Ohio) crude petroleum: 1887 to 1902.*

YEAR.	Highest.	Lowest.	Average.	YEAR.	Highest.	Lowest.	Average.
1887	$0.15	$0.15	$0.15	1895	[1]$1.27	[2]$0.50	$0.71¾
1888	0.15	0.15	0.15	1896	[1]0.90	[2]0.52	0.65¼
1889	0.15	0.15	0.15	1897	[1]0.60	[2]0.41	0.48
1890	0.37½	0.15	0.30	1898	[1]0.80	[2]0.41	0.61¼
1891	0.35	0.30	0.30¼	1899	[1]1.17	[2]0.74	0.89¾
1892	0.37½	0.35	0.36¼	1900	[1]1.26	[2]0.74	0.98⅜
1893	0.49	[2]0.40	0.47¼	1901	[1]0.94	[2]0.74	0.86
1894	[1]0.55	[2]0.47½	0.48	1902	[1]1.15	[2]0.80	0.88½

[1] North Lima. [2] South Lima.

REVIEW OF THE INDUSTRY BY STATES AND TERRITORIES.

Alaska.—There are three known localities along the west coast of Alaska in which there are surface indications of the existence of natural petroleum. The first begins a short distance northwest of Cape Yaktag, 450 miles northwest of Sitka and just west of Mt. St. Elias. There are numerous natural springs of petroleum and water extending for a distance of 25 miles farther northwest, in a line parallel to that of the coast. For this distance there is a continuous line of foothills 500 to 600 feet in height, cut by numerous streams. Along the streams, near the axis of this uplift, there are numerous petroleum indications. Seventy-five miles farther west along the coast line, between Cape Suckling and Cape Martin, near the waters of Catella bay, there are also springs of petroleum associated with sulphur water and natural gas a short distance inland. Still farther inland there are seams of bituminous coal from 3 to 8 feet in thickness and of superior quality. This section is generally known as the Kayak region, as it is nearly opposite Little Kayak Island. Seventy-five miles farther north, also on the mainland opposite Kochetnak bay, at the mouth of Cooks inlet, there are also some surface indications of petroleum.

One of the original discoverers of these surface indications was Mr. R. C. Johnson, who ran across them while exploring the numerous small creeks along the ocean for gold. A company he organized succeeded in getting down a well late in the summer of 1902, which, at 365 feet, gave very promising results. It was located on one of the small streams entering Catella bay from the east on a low divide extending toward Point Hay, where there were abundant surface exposures and small feeders of petroleum constantly coming to the surface. The following is a record of the well as reported by the company:

Log of well east of Catella bay, Kayak district, drilled in 1902.

FORMATION.	Feet.
Total	366
6 feet surface drift	6
10 feet decomposed shale	16
140 feet light colored shale	156
18 feet fine grained sandstone	174
One half foot coal contained in the sandstone	174½
190 feet dark shale, very hard	364½
One half foot quartz containing iron pyrites and contained in the shale	365
1 foot oil sand and flow of oil	1
Length of 12-inch casing	229
Length of 9⅝-inch casing	340

Numerous small showings of petroleum and natural gas were encountered as the drill proceeded downward. At 366 feet a large quantity of oil was developed, which is reported to have flowed, and the well is said to have continued to flow until capped.

California.—Although there were fewer wells drilled in California in 1902 than in 1901, the production reported showed a large increase over that of the previous year, which is partially due to the large quantity held from the previous year at the wells owing to the lack of transportation. The production in 1902 placed this state third in the order of output; only Ohio and Texas produced greater quantities. There is no question that if all the facilities for transportation had been supplied the production would have been largely increased.

Under these conditions the production in 1902 was 13,984,268 barrels, produced by 2,574 wells. The value of the production was $4,873,617. The average price was 34.8 cents per barrel. There were stored at the close of 1902 nearly 4,000,000 barrels of petroleum awaiting transportation.

The completion of the pipe line must have the effect of relieving this condition in the Kern river field and of delivering large quantities of petroleum to Point Richmond, on San Francisco bay, where it will find a ready market as fuel. This is especially desirable, as there is a scarcity of coal on the Pacific coast.

The importation of coal fell off more than 25 per cent during 1902. The number of large manufactories and railroads using this liquid fuel almost exclusively is rapidly increasing, so that the indications are that the importation of coal must suffer a still greater decrease, and the introduction of petroleum as a fuel must become general. There can be at least 25,000,000 barrels annually disposed of as fuel in California alone. It has been demonstrated that the use of cheap fuel is one of the chief aids to commercial supremacy, and with the development of this and other natural advantages California may become one of the prominent manufacturing states.

There were 425 wells completed during 1902, but of this number 102 were dry or unproductive, leaving 323 productive wells. The total number of pumping wells was 2,539 and of flowing wells, 35.

Wells were drilled in 18 counties in California during 1902, from the extreme northern county of Humboldt to San Diego on the south. The counties in which the greatest production was secured are, in the order of their output, Kern, Los Angeles, Orange, Fresno, Ventura, Santa Barbara, and San Mateo. Of the total production, 69.4 per cent came from Kern county, 13.9 per cent from Los Angeles county and the remaining 16.7 per cent from the remaining productive counties.

In drilling the many wells in numerous portions of the state only one new pool was discovered—in Santa Clara, near Sargent Station—where, at a depth of 800 feet, a producing sand was found which yielded 80 to 90 barrels per day. There were a number of test wells drilled near Half Moon bay, in San Mateo county, but these produced only a limited quantity of a high grade crude petroleum. There is a great variety of crude petroleum produced in California, ranging from a black, tarry liquid of 11° Baumé to water-white naphtha. The great proportion is a heavy, dark petroleum of about 16° Baumé eminently fitted for fuel purposes.

Bakersfield is the largest producing district in California. It is generally known as the Kern river field, and is located in Kern county, a few miles north of the city of Bakersfield. There are two other fields to the south, known as the Sunset and McKittrick pools, but these are as yet insignificant in production when compared with the Kern river field. The petroleum produced in this latter field varies from 11° to 17° Baumé. There is a remarkable bed of sand, ranging from 200 to 500 feet in thickness, found in most of the wells, and considerable sand and some water are found in the crude petroleum. This is separated by allowing the petroleum to stand in large ponds, although in some instances it is necessary to heat the petroleum to secure a complete separation. There is, no doubt, a large quantity of petroleum in this pool, which can be taken out when the conditions of transportation have become more favorable, as during 1902 many of the wells were shut in for a portion of the time.

The Los Angeles field is one of the original fields in this state and has produced a large quantity of fuel petroleum for a number of years. There was a slight decline in the production of 1902 as compared with that of 1901. The wells in this field range from 600 to 1,200 feet in depth and vary in production from 2 to 25 barrels per day. The petroleum is black, with a gravity varying from 15° to 17° Baumé. Recently a pipe line has been constructed connecting the Whittier pool with Los Angeles. There is also a producing field at Newhall, at the head of the Santa Clara canyon, in this county, which yields a superior grade of petroleum.

Some very good wells have been secured in Orange county at Fullerton, at Brea canyon, and elsewhere in the vicinity. A few of these wells were drilled to a depth of 2,400 feet, and the production at first reached as much as 1,000 barrels per day. The Whittier pool, in Los Angeles county, lies just northwest of the Fullerton pool. These pools produce a petroleum of high grade, which is in demand for refining and for which a high price is paid.

The Coalinga field, on the east flank of the Coast Range in Fresno county, was opened up in 1897. Most of the petroleum produced in this field ranges from 22° to 38° Baumé, although there is some petroleum as heavy as 11° Baumé. In the northeastern portion of the field the gravity of the production ranges from 20° to 28° Baumé. It is suitable for refining and is in demand as an enricher of manufactured gas.

Ventura county continued to produce petroleum in a comparatively small way along the Santa Clara valley to the south. There is considerable variation in the character and gravity of the petroleum produced. A very light petroleum of about 35° Baumé is found in Pico canyon near the Los Angeles county line.

Operations were active in Santa Barbara county in 1902. A large production was secured on Los Alamos creek, which locality has been operated successfully for several years. A well with a capacity of 200 barrels was found near Lompoc. Summerland district is in this county, but was not actively operated during 1902, and has declined in production.

The problem of transportation from the California oil fields has not been fully solved. The oil development of the state has been much retarded by the lack of facilities for getting the oil to market. Most of the production is within reach of the railways by short pipe lines, but there has been a deficiency of cars to meet the demands, and consumers have hesitated to adopt oil as fuel because of the uncertainty of getting a supply when needed.

An 8-inch pipe line is being constructed from the Kern river district to a refinery at Point Richmond, on San Francisco bay, which eventually will have branches to the important oil producing localities in the San Joaquin valley. A branch to the Coalinga field is now in process of construction. The main pipe line will be 278 miles in length with 10 pumping stations, and the oil will be heated to permit its easy pumping. The completion and operation of this pipe line are matters of very great importance to the industry of the state. A railway, chiefly for the transportation of crude oil, is projected from the Sunset district to tide water at Port Harford, but at the close of 1902 little progress had been made toward its construction.

Tankage supply stations have been established in the Hawaiian Islands, and large tank steamers are now running to the islands from San Francisco and southern California ports. Large supply stations are also being installed at various points along the coast as far north as Washington, and these will be supplied by the railways or by ocean transit as will be most convenient.

The chief use of California petroleum is as fuel, and the market for it was gradually extended during 1902. The railways of the state are adopting it as rapidly as possible. The Southern Pacific Railway has established a large amount of tankage on its line at different points. Both the Southern Pacific and the Atchison, Topeka and Santa Fe railways are the owners of tracts of oil lands from which part of their supply is drawn. The use of the heavy oils for improving roads is increasing.

The price of California oil during 1902 was low, but some advance took place toward the close of the year. Large contracts for the delivery of oil at the wells for a period of five years, however, were made at the rate of 20 cents a barrel. This price applied to the heavier oils of the Kern river and McKittrick districts. Lighter oil produced in the southern part of the state commanded as high as $1.00 and $1.20 a barrel where the quality was such as to permit refining into illuminating oils.

During the year the number of refineries in the state increased from 11 to 33. Most of them were small and designed more particularly for the production of asphalt from the heavy oils, which yield from 40 to 50 per cent of this material. The distillates obtained in this way are used largely for domestic fuel, for gas making purposes, and, to a slight extent, for spraying fruit trees. The largest installation for refining California oils is at Point Richmond, near San Francisco. In the following table is shown the production of petroleum in California by counties for the years 1897 to 1902:

TABLE 32.—*Production of crude petroleum in California, by counties: 1897 to 1902.*

[Barrels of 42 gallons.]

COUNTY	1902	1901	1900	1899	1898	1897
Total production	13,984,268	8,786,330	4,324,484	2,677,875	2,249,088	1,911,569
Total value	$4,873,617	$4,971,540	$4,076,975	$2,660,793	$2,376,420	$1,918,269
Average price per barrel	$0.35	$0.57	$0.94	$0.99	$1.06	$1.00
Fresno	572,498	780,650	532,000	439,372	154,000	70,140
Kern	9,705,703	4,493,455	892,500	15,000	10,000	
Los Angeles	1,938,114	2,188,633	1,730,263	1,409,356	1,462,871	1,327,011
Orange	1,028,549	724,565	372,200	108,077	60,000	12,000
Santa Barbara	242,840	135,900	153,750	208,370	132,217	130,136
Santa Clara			771	1,500	3,000	1,000
Ventura	484,764	463,127	418,000	496,200	427,000	366,292
Unapportioned	[1]11,800		225,000			

[1] San Mateo.

Colorado.—There was a considerable amount of new work accomplished in Colorado during 1902, although the product was but 396,901 barrels, a decrease of 63,619 barrels as compared with 1901. The production of the Boulder pool was only 11,800 barrels. Its quality was superior to any other petroleum found west of the Mississippi river, and its gravity when fresh was 42.5° Baumé.

The new Boulder field was partially opened up in 1901 by the McKenzie well, which found petroleum at a depth of 2,720 feet and was the cause of the drilling of a number of deep wells in this new field. These, however, produced only a limited quantity of high-grade petroleum. There were 48 wells drilled in the state, 28 of which were dry. The total number of producing wells was 77, and the number abandoned during the year, 6. There were 60 tanks at wells, with a combined capacity of 41,579 barrels.

An important deep well was drilled in the old Florence field south of the city, which at a depth of 3,650 feet found a pay streak never before reached by any of the wells in that field. The strata in which the petroleum is found stored in this field, and also in the Boulder field, are considered to belong to the Fort Pierce group of the Montana Cretaceous. The Florence field furnished nearly 98 per cent of the state's production in 1902.

The petroleum is of a dark green color, with a gravity of from 31° to 32° Baumé, and in refining gives a fair yield of the more valuable products. The production in 1902 sold for $484,683, an average of $1.22 per barrel being secured.

Illinois.—The production of petroleum in this state, although extending over a period of nearly fifteen years, has been insignificant. Even the small production secured seems to be growing smaller. There is a probability, however, that the state may yet produce sufficient petroleum to become of significance as a producer.

Nearly all of the petroleum comes from Litchfield, Montgomery county, and is used locally for lubricating purposes. Its gravity is 22 Baumé. The wells are from 640 to 670 feet in depth. There is a small production from shallow wells at Washington, Tazewell county. It finds a sale as lubricating petroleum, the production, valued at $5 per barrel, amounting to $1,000. In October, 1901, petroleum was reported to have been found in small quantities 6 miles west of Canton, Fulton county, and also in the town of Herscher, Kankakee county. The production of the state since 1889 has been as follows:

TABLE 33.—*Production of petroleum in Illinois: 1889 to 1902.*

[Barrels of 42 gallons.]

YEAR.	Quantity.	YEAR.	Quantity.
Total	6,576	1895	200
		1896	250
1889	1,460	1897	500
1890	900	1898	360
1891	675	1899	360
1892	521	1900	200
1893	400	1901	250
1894	300	1902	200

Indiana.—The production in this state comes almost entirely from one horizon, known as the Trenton limestone. There are probably 28 barrels of salt water pumped for each barrel of petroleum produced.

A number of wells that were formerly natural gas producers have been drilled deeper and have found petroleum in paying quantities. It is a field of easy access, and is abundantly supplied with facilities for transporting supplies, as well as with pipe lines, for marketing the petroleum. The production in 1902 was 7,480,896 barrels of crude petroleum, valued at $6,526,622. This is a gain of 1,723,810 barrels in quantity, and $1,703,796 in value over 1901, the increase amounting to 29.9 per cent in quantity and 35.3 per cent in value. Indiana was the only state in the northeastern portion of the United States that gave an increased production in 1902.

The most active operations during 1902 were in Grant county, one-third of the new wells in the state being drilled in this county, adding a considerable new and rich territory to the known productive area of the state. The section near Marion once famous for large natural gas wells is now important as a petroleum producing region. The exhaustion of the gas enabled operators to drill the wells deeper, and results have been remarkably successful. The counties of Adams, Blackford, Delaware, Huntington, Jay, Madison, Randolph, and Wells were all more or less conspicuous for new wells and increased production during the year. In addition to the production from the regular limestone strata of the Trenton horizon, there are a number of small pools in newer horizons that have produced small quantities of petroleum, but no very successful wells were discovered, although there was a small production in Dubois, Jasper, Martin, and Vigo counties.

The following table gives the production of petroleum in Indiana from 1891 to 1902:

TABLE 34.—*Production of petroleum in Indiana: 1891 to 1902.*

YEAR.	Quantity (barrels).	Total value at wells of all oil produced, excluding pipeage.	Value per barrel.
1891	136,634	$54,787	$0.40
1892	698,068	260,620	0.37
1893	2,335,293	1,050,882	0.45
1894	3,688,666	1,774,260	0.48
1895	4,386,132	2,807,114	0.64
1896	4,680,732	2,954,411	0.63
1897	4,122,356	1,894,412	0.45⅞
1898	3,730,907	2,214,322	0.59⅜
1899	3,848,182	3,363,738	0.87⅜
1900	4,874,392	4,693,983	0.96 3/10
1901	5,757,086	4,822,826	0.83¾
1902	7,480,896	6,526,622	0.87¼

The whole number of producing wells in 1902 was 8,224, of which 8,223 were pumping and 1 flowing. There were 2,932 wells drilled, of which 443 were dry and 2,489 were producers. The abandoned wells numbered 772. The number of receiving tanks at the wells was 2,568, having a combined capacity of 592,172 barrels.

Kansas.—This state was the scene of a large amount of development during 1902. The main portion of the production was secured in Allen, Neosho, and Wilson counties. Several new pools were opened up, and the Chanute pool opened in 1901 was greatly extended. No very large gushers were developed, yet a large percentage of the wells drilled were profitable producers. The depth of the wells in the Kansas field is not great, ranging from 750 to 900 feet, and their production runs from 10 to 50 barrels.

The petroleum and natural gas developed in southeastern Kansas are generally found in a dark sand from 15 to 25 feet in thickness, almost immediately above the Mississippian limestone. It is not a persistent stratum, but is more or less a local deposit in the Cherokee shales. In other sections of the state these shales carry deposits of bituminous coal. There is a general dip to the west, which soon carries this formation too deep to be reached by ordinary methods of drilling. Indications point to the probability of Kansas becoming a large producer of petroleum, and in 1902 its production increased 85.2 per cent; the pipe lines and transportation companies could not take care of it. Early in 1903 a pipe line was constructed, connecting the refinery at Neodesha with the newly developed field of Chanute and Humboldt.

The total number of wells drilled in the state of Kansas during 1902 was 282. Of this number, 245 were productive and 37 dry holes. The total number of pumping wells was 367, and the flowing wells numbered 52. There were 14 wells abandoned. There were 304 tanks at the wells, with a combined capacity of 43,238 barrels.

The total production of oil in Kansas, so far as records have been obtained, is as follows:

TABLE 35.—*Production of petroleum in Kansas: 1889 to 1902.*

[Barrels of 42 gallons.]

YEAR	Quantity	YEAR	Quantity
1889	500	1896	113,571
1890	1,200	1897	81,098
1891	1,400	1898	71,980
1892	[illegible]	1899	69,700
1893	18,000	1900	74,714
1894	40,000	1901	179,151
1895	44,430	1902	331,749

The value of the petroleum produced in Kansas in 1902 was $292,464, an average of 88 cents per barrel. The average price per barrel received in 1901 was 84 cents.

Kentucky. The events of 1902 were of considerable importance, the extensive pipe line system being completed from Parkersburg, W. Va., to Somerset, near the southern boundary of the state. There are also branch lines from the main trunk line to Barbourville, Ragland, and the Prestonsburg fields. The entire length of the trunk line from where it crosses the state line from West Virginia to the Tennessee state line is 190 miles. There are also 85 miles of branches, making a total of 275 miles of pipe line. A very considerable amount of development work was done in Kentucky during 1902 in the counties of Allen, Barren, Bath, Clark, Clay, Clinton, Cumberland, Estill, Knox, Lewis, Lincoln, Menifee, Morgan, Powell, Pulaski, Rowan, and Wayne. The production of petroleum in 1902 was 248,950 barrels, valued at $172,837, an average of 69 cents per barrel, a gain of 81.4 per cent in quantity over the production in 1901.

Louisiana. The presence of petroleum in this state has been known for a number of years, as there were numerous localities in the southwestern portion where springs carrying a proportion of petroleum were known to exist. The developments in 1901, a few miles to the southwest, were the incentive to a larger amount of prospecting in various portions of the state during the years 1901 and 1902. There was some slight production in this state during the year 1901, but there were no sales, and no value could be given. The most successful development was near Jennings, 90 miles east of Beaumont, Tex., and 190 miles west of New Orleans. There were also a number of productive wells drilled at Welsh, 12 miles west of Jennings, and a number of wells in which there were indications of petroleum were drilled at Calcasieu, Lake Charles, Crowley, Lafayette, and Sulphur. In several other localities there were outbursts of natural gas accompanied by a slight showing of petroleum. The most important field discovered in the latter part of 1901 was located 6 miles northeast of Jennings, in Acadia parish.

At a depth of 1,822 feet one well found a considerable amount of petroleum in a bed of loose sand. It flowed spasmodically considerable quantities of petroleum, mixed with more or less sand, to a considerable height above the derrick. Owing to caves and several unforeseen conditions this well had to be abandoned at the close of 1902. In this pool in the same stratum producing the petroleum a strong gas pressure was encountered which threw out large quantities of loose sand, frequently clogging up the casing and thereby shutting off the flow. Some of these difficulties were overcome by the insertion of perforated casing in the bottom. Little or no solid formation is found in the drilling of these wells. The petroleum is about 26° Baumé, and is said to be somewhat superior to that produced in the Beaumont and Sour Lake pools.

About 12 miles west of Jennings the Welsh pool is located. There are indications that a considerable area of productive territory would be found in this locality. The same difficulty presented by beds of loose sand associated with petroleum and natural gas is encountered in this field. The Jennings and Welsh fields had been connected by pipe line with both railroad and tide water transportation, and a large amount of the product has been marketed as fuel petroleum.

Missouri. There has been a small production of petroleum in this state since 1889, the product being secured from a shallow well located in Bates county, near the town of Merwin. It is heavy and dark in color, and finds sale as a lubricating petroleum.

During the year 1902 seven shallow wells, from 340 to 490 feet in depth, were drilled at Belton, in Cass county, and a small quantity of lubricating petroleum was secured. The production in this field, although insignificant in 1902, showed an increase over the previous year.

Michigan. The production of petroleum in Michigan has been somewhat irregular since it was first developed in a small way in 1900 near Port Huron. The principal source of petroleum is the Corniferous limestone, and the pay rock, 13 feet in thickness, is found at a depth of 524 feet. This same stratum is productive to the east, in Canada.

Montana. In the northern part of this state, near the Canadian border and east of the Flathead river, there are a number of indications of petroleum in natural springs. North of this section, in Alberta, Canada, a recent strike of petroleum is reported on the waters of the Kootenai river. In the southeastern portion of this state, in Carbon and Sweet Grass counties, some petroleum indications are reported. Three wells were recently completed in Carbon county, in which, however, only a very small quantity of petroleum was secured.

Nevada. Although several wells were drilled in this state during 1901 and 1902 no production of petroleum was secured. Several wells drilled in the vicinity of

Elko encountered sand and shales similar to those in which petroleum is found in other localities, but no petroleum was developed.

New Mexico.—There are indications of petroleum and asphaltum deposits scattered over a large area in New Mexico, but nothing yet has been developed in the way of productive wells. There are a considerable number of natural showings of petroleum in San Juan county, and indications are reported in the Salado region near Santa Rosa in Guadalupe county, as well as in Colfax, Eddy, Lincoln, Otero, and Union counties, all of which remain to be tested.

New York.—For the sake of conducting the business of collecting the crude petroleum in a convenient manner, and keeping the same grade of petroleum together, the producing areas in the several states have been divided into districts. These districts are not always separated by state lines, as in several instances a producing area extends from one state into another, and the complete separation of the products of the different states is more or less difficult. This is particularly so in the Appalachian field.

The productive area of petroleum in New York is located in the southwestern portion of the state, and embraces the most northeastern part of the Appalachian field. There are two districts, one known as the Allegany district, which is entirely within the state, and the other as the Bradford district, which extends as a continuous producing area into Pennsylvania. The entire production of petroleum in 1902 was 1,119,730 barrels, valued at $1,530,852, an average of $1.367 per barrel. The number of barrels produced in 1902 showed a decrease of 7.2 per cent, yet the value of the production increased $70,844, as compared with 1901. During 1902, 8,443 wells were reported by 2,123 companies or individuals. There were 626 wells drilled, of which 95 were dry and 531 productive, and 170 wells were abandoned. There were 8,178 pumping wells operated during 1902.

Ohio.—Since 1895 Ohio has produced more petroleum than any other state. In the southeastern part of the state petroleum has been known to exist for many years. The field in the northwestern portion was developed in 1885. There are two well-defined grades of petroleum produced. That in the southeastern portion is similar to the petroleum produced in Pennsylvania and West Virginia; that in the northwestern portion is a peculiar variety of petroleum, containing a considerable percentage of sulphureted hydrogen. For years it was extensively used as a fuel petroleum, as the sulphureted hydrogen imparted a very disagreeable odor to the refined products. It was only after several years that it was successfully refined.

The total production of Ohio in 1902 was 21,014,231 barrels, valued at $20,757,359. Of this amount there were 5,136,366 barrels produced in the southeastern portion, which is a part of the Appalachian field, and 15,877,730 barrels produced in the northwestern portion, known as the Lima-Indiana field. There was also a very small amount of lubricating petroleum produced in this state, in the Mecca and Belden fields, amounting to 135 barrels. This commanded a high price. The value of petroleum produced in the southeastern portion of the state was $6,471,821. That produced in the Lima-Indiana portion was valued at $14,284,072. The output of the Mecca and Belden pools was valued at $1,466. Ohio has produced 24.4 per cent of all the petroleum that the United States has produced since the beginning of the petroleum production. The total number of wells completed in the state during 1902 was 5,313. Of these 3,532 were in the Lima-Indiana field and 1,781 in the southeastern field. Of the total number 894 were dry and 4,419 productive, which includes 3 flowing wells. There were all told 39,056 producing wells, and 2,533 wells were abandoned.

The total quantity and value of crude petroleum produced in Ohio in all fields during 1902 and 1901 are shown in the following table:

TABLE 36.—*Total quantity and value of crude petroleum produced in Ohio: 1902 and 1901.*

DISTRICT.	1902			1901		
	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.
Total	21,014,231	$20,757,359	$0.99	21,648,083	$20,533,571	$0.95
Lima	15,877,730	14,284,072	0.90	16,176,293	13,911,612	0.86
Southeastern	5,136,366	6,471,821	1.26	5,470,850	6,619,342	1.21
Mecca Belden	135	1,466	10.86	940	2,617	2.78

The gross output of the state has exceeded 21,000,000 barrels for the last four years. It will be seen that during 1902 there was a decrease in the production of 633,852 barrels as compared with 1901. In 1901 there was a decline from 1900 of 714,147 barrels.

The production of the Lima (Ohio) district since 1889 has been as follows:

TABLE 37.—*Production of petroleum in the Lima (Ohio) district: 1889 to 1902.*

YEAR.	Quantity (barrels).	YEAR.	Quantity (barrels).
1889	12,153,189	1896	20,575,138
1890	15,014,882	1897	18,682,677
1891	17,315,978	1898	16,590,416
1892	15,169,507	1899	16,377,174
1893	13,646,804	1900	16,884,158
1894	13,607,844	1901	16,176,293
1895	14,850,000	1902	15,877,730

The production of the southeastern Ohio district for the same period is given in the following table:

TABLE 38.—*Production of petroleum in the southeastern Ohio district: 1889 to 1902.*

YEAR.	Quantity (barrels).	YEAR.	Quantity (barrels).
1889	317,037	1896	3,365,365
1890	1,108,334	1897	2,877,193
1891	422,883	1898	2,147,610
1892	1,190,302	1899	4,764,135
1893	2,601,394	1900	5,475,589
1894	3,183,870	1901	5,470,850
1895	3,693,248	1902	5,136,366

The production of the Mecca-Belden lubricating oil districts of Ohio has decreased from 2,283 barrels in 1900 to 940 barrels in 1901 and 135 barrels in 1902. This is the highest grade natural petroleum produced in the United States, but the demand for it is very small and operations are at a standstill. The average price for the Mecca oil in 1902 was $15.91 per barrel, or about 38 cents per gallon. This is much greater than the price of the manufactured article, which has in a measure driven this natural product out of the market.

Oklahoma.—There are many natural petroleum seeps in this territory, but nothing in the way of established production of petroleum was reported for 1902. Some oil is produced quite near the boundary line of Indian Territory. In addition numerous springs and wells have indications of petroleum, and liquid and solid asphalt have been found in shafts and water wells. Guthrie, Lawton, Fort Sill, Richards, and Granite all have a number of natural vents, showing both petroleum and natural gas, and in all probability a few years will see this territory placed on the list of regular producers.

Oregon.—A number of test wells were drilled in Lane, Douglas, Jackson, and Wasco counties, none of which found petroleum or natural gas. In Josephine county there are several springs reported on which a film of petroleum collects.

Pennsylvania.—Of the entire production of petroleum in the United States since the first discovery of the oil in 1859, Pennsylvania has produced one-half of the entire output. The production of petroleum in Pennsylvania in 1902 was 12,063,880 barrels, amounting to 13.5 per cent of the total, valued at $15,266,093. The number of wells producing in that year was 37,806. The number drilled was 3,034, of which 2,275 were productive and 759 were dry. The abandoned wells numbered 1,879. There were 20,323 tanks of varying sizes at the wells, with a capacity of 1,864,755 barrels.

The petroleum producing areas of Pennsylvania are divided into districts on the basis of quality of output and county lines. A district is in some cases subdivided into pools which produce similar grades.

The Bradford district is located in McKean county in the most northern portion of the state, a portion of it extending over into New York. It was formerly a very prolific region, nearly the entire area being underlaid by a productive sand 50 feet thick, but for several years it has shown the effect of drainage by a steadily decreasing output. In 1881 this district produced 23,000,000 barrels of petroleum. Its production for 1902 was 2,506,981 barrels.

The Gaines district is located in Tioga county, just east of the Potter county line. It is the most easterly district producing petroleum in the United States. Its production for 1902 was 24,881 barrels, which was 12,610 barrels less than that of the previous year. The wells in this district are known as "flashy"—that is, they produced a large amount when first opened up, but soon dropped off and became very small producers.

Clarendon and Warren district includes the western portion of McKean county, the eastern portion of Warren county, the northeastern portion of Forest county, and the northwestern portion of Elk county. In this district some of the finest petroleum produced in the United States is found, known as Tiona petroleum, which commands a higher price than the ordinary Pennsylvania variety. The Clarendon and Warren district proper produced 468,420 barrels in 1902, which is a gain of 63,987 barrels over the previous year.

The lower district contains the oldest wells in the Appalachian field, along the valley of Oil creek. Some of these wells have been producing over twenty-five years. The district includes a portion of Forest, Venango, Clarion, and Butler counties. There is a great number of wells of small production in this district. The production in 1902 was 4,754,979 barrels, which is a decrease of 100,070 barrels as compared with the previous year. Many deep wells were drilled in the new Speechley field, near the old Modac pool, in Butler county, and there were also a number of large wells secured in the Fourth sand near Middletown, which, however, rapidly declined.

In the Allegheny county district no new pools were developed in 1902. This district produced 1,376,212 barrels in 1902, which was a decline of 64,755 barrels as compared with the previous year. This district contained the famous McDonald pool, which in 1891 increased its production to 10,317,258 barrels.

The Washington county district produced 1,396,831 barrels in 1902, which was a gain of 96,432 barrels over the previous year. There were no new pools discovered, but several extensions of the older pools were developed.

Beaver county district produced during the year 1902 528,734 barrels. There was a decline of 270,544 barrels in 1902 compared with 1901.

Greene county district also showed a slight decrease in 1902, when the output amounted to 721,574 barrels against 771,708 barrels in 1901. All the wells drilled in this section are from 2,400 to 3,000 feet in depth, which makes the drilling and operating expensive. A dry hole under such circumstances means a loss of between $6,000 and $7,000. Some of the older wells in this region are remarkable, on account of their continuous production, the decline being very slight during a series of years.

Franklin district is a subdivision of the lower district, and has long been celebrated for the production of the finest natural lubricating petroleum found in the United States. The production of this variety of petroleum is secured from the First sand, which has a thickness of about 50 feet. This stratum is at a comparatively shallow depth, and is associated with large quantities of salt water. Many of these wells produce only a few gallons of this superior grade of petroleum in a day. The production of this district in 1902 was 50,555 barrels, which showed a decline of 4,607 barrels when compared with the previous year.

The production of the Pennsylvania and New York fields for the years 1891 to 1902, inclusive, by districts, is shown in the following table, all of the districts being wholly within Pennsylvania, except Allegany and a portion of the Bradford district referred to under the head of New York:

TABLE 39.—PRODUCTION OF CRUDE PETROLEUM IN PENNSYLVANIA AND NEW YORK, BY DISTRICTS: 1891 TO 1902.

[Barrels of 42 gallons.]

YEAR.	Total.	Allegany county, N. Y.	Bradford.	Bullion.	Clarendon and Warren.	Grand Valley.	Hickory Run.	Middle.	Tioga county.	Second sand.
1891	33,009,236	1,121,575	5,452,418	117,463	360,227	196,304	47,551	1,320,000	....	268,855
1892	28,422,377	908,603	4,291,061	....	372,523	128,101	....	1,115,139	....	272,011
1893	20,314,513	795,709	3,702,138	....	327,680	51,700	....	1,219,067	....	245,205
1894	19,019,990	656,845	3,370,835	....	338,570	46,000	....	1,169,628	....	315,724
1895	19,144,390	637,139	3,214,868	....	369,747	20,588	....	1,130,403	....	290,872
1896	20,584,421	736,008	3,603,751	....	385,291	....	....	956,790	....	....
1897	19,262,066	771,606	3,904,230	....	378,075	....	....	1,329,148	....	....
1898	15,948,464	757,192	3,444,299	....	414,212	....	....	932,000	....	....
1899	14,374,512	807,814	3,206,345	....	414,452	....	....	528,140	....	....
1900	14,559,127	817,326	3,022,198	....	383,593	....	....	452,136	115,565	....
1901	13,831,996	765,402	2,757,603	....	404,131	....	....	176,185	57,491	....
1902	13,183,610	768,753	2,506,981	....	468,420	....	....	162,762	24,882	....

YEAR.	Tarkill and Egypt.	Tiona.	Tidioute and Titusville.	Lower.	Washington county.	Allegheny county, Pa.	Beaver county.	Greene county.	Franklin.	Smiths Ferry.
1891	808,275	553,730	837,287	6,952,539	2,997,278	10,317,258	943,223	341,813	65,185	29,000
1892	....	475,708	659,164	6,837,703	2,452,588	10,196,856	623,372	192,108	58,459	29,000
1893	....	286,507	225,318	5,896,969	2,057,561	5,488,792	465,300	71,377	66,278	20,793
1894	....	318,611	183,425	5,760,574	1,720,780	4,559,342	460,700	64,176	57,070	2,620
1895	....	325,843	50,129	6,904,356	1,676,676	3,864,111	472,276	116,931	48,711	2,400
1896	....	309,252	....	7,530,807	1,975,169	4,380,007	650,296	91,796	49,329	2,704
1897	....	201,585	....	6,825,509	2,175,719	2,958,540	317,926	258,065	48,880	2,400
1898	....	251,447	....	5,700,443	1,742,677	2,301,651	230,796	525,177	56,090	2,180
1899	....	212,217	....	5,080,182	1,460,025	1,988,754	232,104	381,493	61,085	1,150
1900	....	256,915	....	5,364,398	1,375,340	1,706,886	416,319	588,379	59,036	1,300
1901	....	466,909	....	4,855,049	1,390,880	1,416,967	709,278	771,708	55,162	1,410
1902	....	421,728	....	4,754,979	1,396,831	1,376,212	528,734	721,574	50,555	1,200

Tennessee.—The production of petroleum in this state since 1896 has been secured in great measure from a remarkable well drilled on the Obey river in Fentress county. This well at a depth of 276 feet struck a deposit of petroleum which alone has produced nearly 40,000 barrels up to the close of 1902. It would seem that this well pierced a cavern either in the Clinton limestone or the upper Hudson river formation. The petroleum is of a light green color with a specific gravity of 0.846 or 35° Baumé. During 1901 the large tanks near this well were connected by a pipe line with the Slickford pool in Kentucky, a distance of 20 miles. During the year 1902 a few small wells were opened in the vicinity of this remarkable well which helped to increase the production in this state. There were a number of wells completed in Pickett, Fentress, and Sumner counties, several of which had a considerable showing of petroleum or natural gas; the greater portion, however, were destitute of petroleum in sufficient quantities to become paying wells. The numerous surface indications over a large area in this state have generally proved misleading. There seems to be an absence of an open, porous, continuous bed that is capable of furnishing a reservoir for the accumulation of petroleum. The wells that so far have proved to be producers, in greater or less amounts, seem to draw their supply from a crevice in the stratum or a cavity in the limestone formation.

Texas.—For a number of years the state of Texas produced an insignificant amount of petroleum from Sour Lake, Nacogdoches, and the San Antonio fields. Its remarkable output in 1902 placed it second in the list, next to Ohio. The year 1896 was notable for the opening of the Corsicana petroleum field, in which a considerable quantity of a very valuable petroleum was discovered. This petroleum is rather dark in color and ranges from 38° to 40° Baumé. A few years later a refinery was erected at Corsicana, where almost the entire production has been successfully refined.

On January 10, 1901, a very remarkable well was completed in southeastern Texas, about 4 miles south of Beaumont, in Jefferson county, and about 20 miles north of the Gulf of Mexico. At the close of 1902 there were some 120 wells producing in this locality. The producing area is confined to about 185 acres, on an elevation or mound which rises to about 15 feet above the general surface of the plain. The summit is nearly 40 feet above the level of the sea. The wells are usually slightly over 1,000 feet in depth, and originally were gushers. Some of them in the early history of the field produced as much as 75,000 barrels per day. Outside of this immediate locality described, nothing but dry holes have been developed, although some of these wells have been drilled to a depth of from 2,500 to 3,000 feet.

Probably no other event in the development of the petroleum industry in the United States created such a profound sensation as the opening up of this prolific territory near tidewater. The productive area near the original well during the summer and fall of 1901 and the early part of 1902 was crowded by a great number of wells, many of which were productive, although the output of the later ones was insignificant in comparison to the output of the earlier. The first well in this pool was located by Capt. A. F. Lucas, who was attracted to the locality by the existence of strong sulphur and acid springs and the presence of pure sulphur, together with a considerable outflow of natural gas. Two unsuccessful attempts had formerly been made to test this locality. A considerable amount of gas pressure in pockets was developed above the oil producing horizons, and this in some instances blew out great volumes of sand and water before it became exhausted.

During the latter portion of 1901 another large pool was partially developed at Sour Lake, 20 miles northwest of Beaumont, underlying the shallow wells that were originally drilled in this locality. In November of that year a well was completed to a depth of 1,500 feet which encountered more or less loose sand alternating with beds of gravel. At a depth of between 850 and 880 feet a deposit of sand was found which gave a large flow of hot sulphur water at a temperature of about 100° F., accompanied by some showing of petroleum. At a depth of 1,040 feet four distinct sands were encountered. These loose sands contained some petroleum associated with hot water, but no considerable quantity was developed.

About the middle of March, 1902, a gusher was opened up at a depth of 683 feet, after 40 feet of very promising oil sand had been penetrated; when the water became exhausted the well began to flow vigorously, accompanied by the outburst of loose sand, which on several occasions completely shut off the petroleum. By the use of casing with larger perforations than had previously been used, the inrush of loose sand was overcome, and many very productive wells were secured.

The gravity of petroleum produced in this region ranges from 22° to 23° Baumé, equal to a specific gravity of 0.92. The fresh oil gives a flash point at 120° F., while upon standing in a tank for some time the flash point is increased to 160° F. In the latter part of 1901 and the year 1902 a number of pipe lines were constructed reaching from Beaumont to Port Arthur and Sabine Pass. Two pipe lines were constructed from Sour Lake to Beaumont.

Twelve miles northwest of Sour Lake, in what was known as the Saratoga district, several productive wells of moderate capacity were drilled with promising indications of an increased production. In the old Nacogdoches district numerous shallow wells were drilled previous to 1895, but no very large producers were secured. A considerable amount of money has been invested in drilling wells and building a pipe line to the railroad in this locality, but operations have been of late years practically abandoned.

In the Bexar county district small quantities of heavy petroleum were produced from wells at a depth of 600 to 800 feet. This pool is located near San Antonio.

The number of wells drilled during 1902 was 252; of these 216 were productive and 36 were dry holes. The number of flowing wells was 70, and the total number of pumping wells was 782, making a total of 852 productive wells. There were 67 wells abandoned during the year. The number of tanks at the wells was 1,010, with a combined capacity of 4,917,923 barrels.

The localities in which petroleum has thus far been found are shown in the following list, arranged alphabetically by counties, the list being taken from Bulletin 18 of the University of Texas:

Anderson county, New Palestine, sand impregnation; Bastrop county, near Elgin; Bell county, western part, small quantities near Belton; Bexar county, Dulnig place, 7 miles south of San Antonio, J. Linn Survey, 10 miles south of San Antonio; Brazoria county, Kaiser mound, near Columbia; Brewster county, 6 miles east of Terlingua, in bituminous shale; Brown county, Brownwood; Burleson county, near Rita; Caldwell county, near Lockhart; Clay county, 2 miles from Hurnville, north of Henrietta; Coleman county, near Trickham; Cooke county, Muenster, west; Coryell county, Gatesville; Denton county, reported 6 miles from Denton; Duval county, Piedras Pintas, near Benavides; Edwards county, reported near Rocksprings; El Paso county, 20 miles north of Vanhorn, in small amount; Gonzales county, near Ottine; Grimes county, near Keith, Lamb Springs neighborhood; Hardin county, Saratoga, Sour Lake; Jack county, 10 miles north of Jacksboro; Jefferson county, the Beaumont field; Live Oak county, Atascosa creek, 12 miles north of Oakville; McCulloch county, near Milburn; McLennan county, near Waco; McMullen county, Crowther; Medina county, near Dunlay; Montague county, St. Jo, east; Nacogdoches county, Oil Springs, 6 miles south of Melrose, Chireno;

Navarro county, the Corsicana field, the Powell field, Frost; Nueces county, Puerto-Richard Kings' ranch; Palo Pinto county, near Strawn, 1 mile north of Mineral Wells; Pecos county, 15 miles northeast of Fort Stockton and 22 miles north of Fort Stockton; Reeves county, Pecos Valley, above and below Pecos City, 9 miles north of Toyah; San Augustine county, San Augustine; Shelby county, near Timpson; Tarrant county, near Fort Worth; Travis county, Walnut creek, 9 miles north of Austin; Wilson county, Sutherland Springs.

The total quantity of crude petroleum produced in 1902, was 18,515,017 barrels, of which 18,083,658 barrels were sold and 431,359 barrels were held in tanks by the producers.

It is estimated that at the close of 1902 storage tanks in the state contained about 7,300,000 barrels, leaving 11,215,017 barrels as the quantity which was either consumed locally or shipped from the state. The total production in 1901, excluding stocks, was 4,393,658 barrels. The gain of 1902 over 1901, excluding stocks, amounted to 311.6 per cent. The value of the crude petroleum produced in 1902 was $4,174,731, an average of 22.55 cents per barrel. Compared with 1901 the total value, excluding stocks, shows a gain of 220 per cent.

The production of crude petroleum in 1902, by districts, was as follows:

	Barrels.
Total	18,515,017
Beaumont	17,852,308
Corsicana	571,059
Powell	46,812
Sour Lake, etc. (beginning in September)	44,838

A comparative summary of the value of crude petroleum at wells sold in 1902 and 1901, by fields (excluding stocks), is as follows:

TABLE 40.—*Value of petroleum sold in Texas, by fields: 1902 and 1901.*

[Barrels of 42 gallons.]

FIELD.	1902			1901		
	Quantity.	Value.	Value per barrel.	Quantity.	Value.	Value per barrel.
Total	[1]18,083,658	$3,998,097	$0.2211	[1]4,393,658	$1,247,150	$0.284
Beaumont	17,420,949	3,563,287	0.2045	3,593,113	630,752	0.1755
Corsicana	571,059	410,534	0.7189	763,424	604,249	0.7915
Powell	46,812	9,863	0.2107	37,121	12,148	0.3273
Sour Lake, etc.	44,838	14,413	0.3215			

[1] Includes small production of petroleum in Bexar county.

The following statement shows the production and stocks in the Beaumont district in 1902 and 1901:

Total production in Beaumont district: 1902 and 1901.

	Barrels.
Total production, including stocks	23,038,191
Production in 1902, including stocks	17,852,308
Production in 1901, including stocks	5,185,883

The stock in tanks at the close of 1902 and 1901 in the Beaumont fields was estimated as follows:

Stock of petroleum in tanks in the Beaumont fields at the close of 1902 and 1901.

	Barrels.
Stock in tanks on January 1, 1902	1,592,770
Increase at the close of 1902	5,707,230
Total amount in tanks at the close of 1902	7,300,000
Shipments during 1902	10,552,308
Total production	17,852,308

By the close of 1902 the iron tankage completed in Jefferson county had a capacity of 5,775,500 barrels. The capacity of the wooden tanks was 200,000 barrels. The earthen tankage is more difficult to determine, as there was a large number of earthen tanks unfinished; but it is probable that enough was completed to contain 2,300,000 barrels. This gives a total capacity of 8,275,500 barrels. There were also 50 large iron tanks, with a capacity of 2,100,000 barrels, erected by the Santa Fe Railway, the Southern Pacific Railway, and the Houston and Texas Central Railroad, scattered over north-central and western Texas, with Beaumont as a starting point. These tanks have a capacity ranging from 10,500 to 55,000 barrels, and are used for the storing of fuel oil to supply locomotives. This last-mentioned tankage, added to the iron tankage of Jefferson county, brings up the total capacity to 7,875,500 barrels for storing the petroleum produced at Spindle Top, Sour Lake, and Saratoga. There were also two large tanks erected at Sour Lake and one at Saratoga to receive the petroleum produced in the last-named localities.

The shipments of petroleum by rail from the Beaumont district are estimated as 9,646 carloads, or 1,462,968 barrels, in 1901, and 67,275 carloads, or 11,426,559 barrels, in 1902. The shipments in 1902 increased by months from 546,881 barrels in January to 1,117,624 barrels in December.

The water shipments, coastwise and foreign, in 1902 aggregated 167,390,829 gallons, of which 139,512,712 gallons, or 83.3 per cent, went to coastwise ports on the Gulf and the Atlantic, and 27,878,117 gallons, or 16.7 per cent, were exported to Habana, Cuba, and Dover and Plymouth, England, chiefly to the last-named port. Of the shipments by water only about 6 per cent were of refined petroleum. The shipments from Port Arthur aggregated 109,050,253 gallons, increasing from 5,560,044 gallons in January to 15,848,750 gallons in December, and the shipments from Sabine Pass aggregated 58,340,576 gallons, increasing from 504,000 gallons in January to 8,675,014 gallons in December. The total water shipments, 167,390,829 gallons, shows an increase from 6,064,044 gallons in January to 24,523,764 gallons in December. The cargoes were 275 in number, 144 from Port Arthur and 131 from Sabine Pass. The shipments from Port Arthur in 1901 were 8,494,794 gallons coastwise and 2,722,902 gallons to foreign ports, a total of 11,217,696 gallons. There were no shipments of refined petroleum from Sabine Pass in 1902.

The exports of crude petroleum from Port Arthur and Sabine Pass in 1901 aggregated 2,276,787 gallons, of a value of $20,061. The exports of crude and refined petroleum from these ports in 1902 to foreign countries were as follows:

Exports from Port Arthur and Sabine Pass, Texas: 1902.

	Quantity (gallons).	Value.
Total	27,878,117	$217,738
Crude	19,641,591	115,415
Naphtha	297,174	4,275
Illuminating	2,824,883	81,778
Residuum	5,114,469	16,270

Utah.—Petroleum in limited quantities has been found on the Green river in Emery county, and it is also reported near Sinbad, where a number of shallow wells have been drilled and small quantities of lubricating petroleum secured. This state in former years produced considerable quantities of natural paraffin, or black wax, from localities in the Sanpete valley, east of Salt Lake, but these have been exhausted. At the present time some gilsonite, a variety of solid hydrocarbon, is produced.

Washington.—A number of test wells were drilled in 1902 in different portions of this state in search of petroleum and natural gas. So far there have been no indications of the existence of either of these substances in paying quantities.

West Virginia.—This state produced considerable petroleum along the Burning Springs uplift a few years after the discovery of petroleum in northern Pennsylvania. It was not until about the year 1889, however, that it became of considerable importance as a producer. In the fall of that year an important well was drilled near Mannington, in Marion county, separated by many miles from any other producing territory. The development of the state after this well proved itself to be a producer was rapid. Although the great depth at which a large portion of the petroleum producing strata were found has somewhat retarded the increase of production, the most conspicuous feature in the development of West Virginia in 1902 was the opening up of the Folsom, the Pine Grove, and the Falling Timber run pools, in Wetzel county. There were also some new developments on the Big Knot and Wolf Penn run, in Ritchie county. However, no pool of any considerable size has been developed for several years, and the production of this state has been on a gradual decline since the year 1900. Some of the first wells drilled west of the Appalachian mountains were located on the Kanawha river near Charleston in search of salt brine. At this point petroleum and natural gas were found many years before oil was drilled for in Pennsylvania.

The production of petroleum in this state in 1902 was 13,513,345 barrels, which were valued at $17,040,317, an average of $1.26 per barrel. There were included in this amount 14,660 barrels of lubricating petroleum, which had a value of $2.31 per barrel. The total number of producing wells in 1902 was 11,138, and of this number 500 were flowing wells. The total number of wells drilled during the year 1902 was 2,193; of this number 1,544 were productive and 649 were unproductive or dry holes. The number of abandoned wells during the year was 1,322.

The quantity and value of crude petroleum produced in West Virginia from 1889 to 1902, inclusive, is shown in the following table:

TABLE 41.—TOTAL QUANTITY AND VALUE OF CRUDE PETROLEUM PRODUCED IN WEST VIRGINIA: 1889 TO 1902.

YEAR.	TOTAL.			REGULAR CRUDE.			LUBRICATING CRUDE.		
	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.
1889	544,113	$653,827	$1.20	519,511	$595,730	$1.147	24,602	$58,097	$2.36
1890	492,578	501,198	1.018						
1891	2,406,218	1,612,826	0.67						
1892	3,810,086	2,119,901	0.556						
1893	8,445,412	5,425,522	0.642	8,433,412	5,398,522	0.64	12,000	27,000	2.25
1894	8,577,624	7,221,717	0.842	8,563,954	7,182,791	0.839	13,670	38,926	2.847
1895	8,120,125	11,038,770	1.359	8,109,782	11,017,651	1.359	10,343	21,119	2.042
1896	10,019,770	11,829,618	1.181	10,005,966	11,794,532	1.179	13,804	35,086	2.542
1897	13,090,045	10,310,178	0.788	13,078,021	10,282,586	0.786	12,024	27,592	2.295
1898	13,615,101	12,426,359	0.913	13,603,136	12,395,858	0.911	11,965	30,501	2.549
1899	13,910,630	18,014,766	1.295	13,892,906	17,973,947	1.294	17,724	40,819	2.303
1900	16,195,675	21,922,702	1.354	16,176,757	21,879,064	1.353	18,918	43,638	2.307
1901	14,177,126	17,172,724	1.211	14,164,665	17,139,244	1.21	12,461	33,480	2.687
1902	13,513,345	17,040,317	1.261	13,498,685	17,006,469	1.26	14,660	33,848	2.309

Wyoming.—The output of petroleum in this state is greatly restricted by the lack of a market near where it is produced. Large bituminous coal deposits and a thinly settled country have prevented more than a slight demand for it. There has been, however, since 1893 a regular production of superior lubricating petroleum at Salt Creek, 50 miles north of Casper, to which place it is hauled by wagons and refined. In the southwestern portion of the state, at Spring Valley, Uinta county, some petroleum of light gravity and superior quality has been produced, but not as yet in commercial quantities. There are numerous petroleum seeps in the western and central portions of Natrona county, and outcrops of sandstone largely impregnated with petroleum on the north flank of the Rattlesnake range of mountains.

In the Pope Agie district, in Fremont county, several successful wells that flow naturally have been drilled. Some of the wells drilled in 1884 still flow petroleum when opened up. It is reported that 4,000 barrels were produced in this region and allowed to remain in earthen tanks, owing to cost of transportation, only a small portion being used for fuel and lubrication. This petroleum is quite heavy and dark and its specific gravity varies from 18° to 23° Baumé.

REVIEW BY YEARS, 1890 TO THE CLOSE OF 1901.

A summary of the principal features in the development of the petroleum industry is herewith presented: it covers the years from the publication of the Eleventh Census in 1890 to the close of 1901.

1890.—One of the most notable features in the petroleum industry in the United States in 1890 was the enormous increase in the production, a gain of 10,660,059 barrels being made over the production of 1889. The principal increase was in Pennsylvania and New York, the increase amounting to 6,970,773 barrels. Discoveries of petroleum were numerous in Pennsylvania, and the borders of some of the older districts had to be extended to embrace a wider area of productive territory. The sections conspicuous for heavy gains were the Glade Run pool in Butler county, the Shannopin pool in Beaver county, and the Montour, Wildwood, and Chartiers pools in Allegheny county. The increased production in Ohio amounted to 3,653,190 barrels and was general throughout both the Lima and the southeastern fields.

The average value of pipe line certificates in the Pennsylvania field declined from 94½ cents per barrel in 1889 to 86⅝ cents in 1890, making a net loss of 7⅞ cents. The average price of Lima (Ohio) petroleum advanced from 15 cents per barrel in 1889 to 30 cents per barrel in 1890.

The state of Indiana was credited with a production of 63,496 barrels in 1890, as compared with 33,375 barrels in 1889, the first year in which Indiana appears in the list of productive states. West Virginia produced slightly less in 1890 than in 1889. Although the original well at Mannington was opened up in October, 1889, it required time to drill the deep wells of that region and to connect them to pipe lines, and the effect of the greater "strikes" upon the production was not at once apparent.

1891.—The amount of petroleum produced in 1891, 54,292,655 barrels, was larger than that of any preceding year and was not exceeded until 1896. The most important event that marked the year was the opening up of the remarkable McDonald petroleum field, in Allegheny and Washington counties, Pa., in July of that year. By September the production of this district reached 41,000 barrels per day. It is estimated that the total production of the McDonald field for the last six months of 1901 was over 6,000,000 barrels. This was probably the most prolific field of petroleum ever developed in the Appalachian field, when its area is considered.

The oil bearing sand was composed of beautiful quartz pebbles from the size of a pea up to that of a hickory nut. It gave up large quantities of petroleum with great rapidity. In this great reservoir the wells soon ceased to be more than ordinary producers, but a few months sufficing to measurably exhaust several of the wells which, when first opened up, flowed at the rate of 15,000 to 18,000 barrels per day. The Wildwood field, in Allegheny county, was also a factor in increasing the Pennsylvania production, although to a much less extent than the McDonald pool, and Butler county furnished some new and fairly productive wells. There was a considerable decrease in the production of the other Pennsylvania districts. There was a large decline in southeastern Ohio, owing to the low prices that prevailed. The production of southeastern Ohio in 1890 was 1,108,334 barrels, as compared with 422,883 barrels produced in 1891. On the other hand, in the Lima field there was a large increase in production.

The Appalachian field produced in the year 1891 a total of 35,848,777 barrels, which is the greatest production on record with the exception of the year 1900, when the production was slightly in excess of these figures. This large production of petroleum had the effect of reducing the price so that the average price quoted for the year 1891 was 67 cents, as compared with 76⅝ cents in 1889. In this year West Virginia began to be conspicuous as a producer of petroleum. The production of 1891 was 2,406,218 barrels, which was due to the opening up of the new field extending from Mt. Morris, near the Pennsylvania state line, to Mannington, in Marion county. Indiana also began to be conspicuous as a producer, having increased its production largely over that of 1890.

1892.—The production in 1892 showed a considerable falling off, due largely to the decline in the yield of the McDonald field in Pennsylvania. West Virginia increased over a million barrels in production, which was due to the increasing yield of the Mannington field and the newly developed Sistersville pool. The Gordon sand, underlying the Big Injun sand, was discovered to be productive south of Mannington. There was a reduction in the output of northwestern Ohio, an increase in that of southeastern Ohio, and a considerable increase in the production of Indiana, due to developments in the Trenton formation. Up to this time a greater portion of the petroleum of the Lima-Indiana fields, in Ohio and Indiana, had been sold for fuel. In this year an increasing amount was marketed for refining, owing to the process lately perfected for the removal of the sulphur. The average price received for the petroleum produced in the Appalachian field was 55⅝ cents per barrel, which, with the exception of 1861, is the lowest quotation on record. The price of Lima-Indiana petroleum was 36⅝ cents per barrel.

There was an increase in the exports of petroleum and its products.

1893. The important features connected with the production of petroleum in 1893 were a decline in the output of the older fields, especially Pennsylvania; an increase in the amount of production in southeastern Ohio, West Virginia, and Indiana; the slight increase in price, and the increase in the refining of Lima-Indiana petroleum. There was also an increase in the quantity exported. Practically all the petroleum produced came from the Appalachian field, the Lima-Indiana field, the Florence field of Colorado, and the districts of southern California. The decline in the entire production in 1893 as compared with 1892 was 2,078,591 barrels. There was a large increase in the output of West Virginia and Indiana. The decline in the Appalachian products of 2,067,322 barrels nearly accounts for the entire shortage. The average price of certificate oil in the Appalachian field was 64 cents per barrel, an increase of 8⅜ cents over that of 1892. In the Lima field the average price of petroleum in 1893 was 47.25 cents, an increase of 10⅜ cents over that of 1892.

The increase of petroleum exports in 1893 over those of 1892 was nearly 60,000,000 gallons, and the total exportation of all varieties of petroleum amounted to 804,221,230 gallons, the largest up to that date.

1894.—The notable events in the progress of the petroleum industry in 1894 were the development of the Ormsby district, in the Bradford field in northern Pennsylvania, the opening of the Williamstown pool, in Wood county, W. Va., and the discovery of a Berea sand pool near Steubenville, Ohio. There were also some promising developments near Marietta, Ohio. The year was also notable for the advent of the state of Wyoming to the list of oil producers, 2,369 barrels being produced by this state. The quality was that of a superior lubricating petroleum. The year showed a very slight increase in production over that of 1893, but the increase in value was over $6,000,000. In the Appalachian field the combined product of New York and Pennsylvania showed a decrease of 1,294,523 barrels. West Virginia showed a slight increase over the preceding year. Southeastern Ohio showed quite an increase, amounting to 581,976 barrels. In the Lima (Ohio) district there was a decrease of only 38,960 barrels. Indiana showed an increase of 1,353,373 barrels, a gain of 58 per cent. The average price of the Appalachian petroleum in 1894 was 83¾ cents, a gain of almost 20 cents per barrel. The average price of the Lima-Indiana petroleum was 48 cents a barrel, general average price 72 cents.

1895. The notable features of the year were the nearly identical production of the Appalachian field with that of 1894; the increased production in Ohio, Indiana, and California; the advance of Ohio to first place, its production for the first time being greater than that of Pennsylvania; the decrease in stocks and the rise in price; and the further extension of profitable producing districts, including the opening up in West Virginia of the Elk Fork pool, east of Sistersville, and of another on Indian creek near the Big Moses well; and successful tests in southeastern Kansas. There was a slight increase in the combined production of New York and Pennsylvania and an increase of over two million barrels in the production of the Lima (Ohio) field. A slight decline, amounting to 457,499 barrels, was recorded in the production of West Virginia. There was an increase of about 700,000 barrels in Indiana and of over 500,000 barrels in California. The total production in 1895 was 52,892,276 barrels. The stocks of crude petroleum in the Appalachian field at the close of 1895 were 5,344,784 barrels, as compared with 6,499,880 barrels at the close of 1894; in the Lima-Indiana field there were 21,494,848 barrels, making a total for both fields of 26,839,632 barrels at the close of 1895.

The price for what was known as Pennsylvania certificate oil was $1.35⅝ cents, as compared with 83¾ cents in 1894, a gain of 52 cents. In the Lima-Indiana district the average price in 1895 was 71¾ cents, as compared with 48 cents in 1894, a gain of 23¾ cents. The average price of the entire production was $1.089 per barrel in 1895.

1896.—This year was remarkable for the large increase in the production which came principally from the state of West Virginia and the Lima-Indiana district in northwestern Ohio, and from the Watsonville pool in McKean county, Pa. There was an increase in the amount of stocks held and a decrease in the price. The entire production for the year 1896 was 60,960,361 barrels, larger than that of any previous year in the history of the industry, and a gain of 8,068,085 barrels over 1895. There was a slight increase in the combined production of New York and Pennsylvania, with an increase of 4,400,000 barrels in Ohio, and an increase of 1,900,000 barrels in West Virginia. A slight increase is to be noted in the production of the state of Indiana, and a large increase in the state of Kansas as compared with that of the previous year.

The new field at Corsicana, Tex., was first opened up during 1896 and produced 1,400 barrels. The total amount of stocks held in the Appalachian and Lima-Indiana fields, at the close of the year 1896, was 33,048,492 barrels, as compared with 26,839,632 barrels at the close of 1895, a gain of 6,208,860 barrels. There was a decrease in the price of petroleum. The average value of what has been called Pennsylvania certificate oil, in the Pennsylvania field, was $1.18 as compared with $1.36 in 1895, showing a decline of 18 cents per barrel. In the Lima (Ohio) field the price fell from an average of 71¾ cents in 1895 to 66¾ cents in 1896, a decline of 5 cents per barrel. The total value of all of the petroleum marketed in 1896 was $58,518,709, an average of about 95.9 cents per barrel. This was an increase in value of only $827,430 over the preceding year.

1897.—The total quantity of petroleum produced in the United States in 1897 was 60,475,516 barrels, a decrease as compared with 1896 of only 481,845 barrels. There was a slight increase in the production of the Appalachian field as a whole, which came principally from West Virginia. There was a decided decrease in the yield of the Lima-Indiana field in the states of Ohio and Indiana. There was also considerable decrease in the number of wells drilled in both of these states as compared with 1896. The production of petroleum in Texas amounted to 65,975 barrels, as compared with 1,450 barrels produced in 1896, and nearly all of it was produced in the Corsicana field. There was an increase in stocks and a still further decrease in price.

There was a decline in value amounting to $17,589,098. The average price per barrel for all the petroleum produced in 1897 was 67.7 cents as compared with 95.9 cents in 1896. There was a decrease of 2,450,837 barrels in the production of the Lima-Indiana field. Colorado increased its output by 23,484 barrels, and the California field by 650,634 barrels. The largest proportional gain, however, was in the Corsicana field in Texas. The stocks in the Appalachian field at the close of 1897 were 11,010,044 barrels, an increase of 1,264,322 barrels. In the Lima-Indiana field the stocks of petroleum at the close of the year 1897 were 22,762,779 barrels, a loss of 539,991 barrels. The total stocks in both fields at the close of 1897 amounted to 33,772,823 barrels, a gain of 724,331 barrels over those at the close of 1896. The average price of certificate or credit balances of Pennsylvania oil in 1897 was 78⅜ cents, as compared with $1.17⅝ in 1896, showing a decline of 39¼ cents. The average price of Lima (Ohio) petroleum was 48 cents, as compared with 66¾ cents in 1896, a decrease of 18¾ cents.

1898.—The quantity of petroleum—55,364,233 barrels—produced in 1898 showed a decrease of 5,111,283 barrels as compared with the 60,475,516 barrels produced in 1897. There was a decrease in both the Appalachian and the Lima-Indiana fields. The average price paid for Pennsylvania petroleum was 91¼ cents per barrel, as compared with 61¼ cents per barrel for the production of the Lima-Indiana field. The initial well in Scio, Harrison county, Ohio, was completed in August. There was a large increase of production in California and Texas, but a decrease in Indiana.

There was a decrease in the number of wells drilled in the Appalachian and the Lima-Indiana fields. The total number drilled in both these fields was 7,186, of which 1,539 were dry, as compared with 8,558 drilled in 1897, of which number 1,964 were dry. The total stocks of these fields at the close of 1898 were 26,967,495 barrels, as compared with 33,772,823 barrels at the close of 1897, a decrease of 6,805,328 barrels. Stocks decreased and the price increased. The exports decreased as compared with 1897.

1899.—The entire production of the United States was 57,070,850 barrels, as compared with 55,364,233 barrels in 1898. The year was conspicuous for the increased production in southeastern Ohio, amounting to over 2,500,000 barrels, principally from the Scio pool, Harrison county, which added over 1,600,000 barrels to the output. The petroleum of this pool was found in the Berea formation at a depth of about 1,200 feet, being quite evenly distributed and of a very superior quality. There was a decrease in the production of Pennsylvania, Colorado, and Kansas, while all the other states showed an increase. There was a considerably increased production in the state of Texas. The average price of all of the petroleum produced in 1899 was $1.132, as compared with 79.8 cents in 1898, showing a gain of 33.4 cents. The average price of what is known as Pennsylvania certificate oil, which includes about 96 per cent of the Appalachian production, was $1.29⅝ per barrel in 1899, as compared with 91¼ cents in 1898, an increase of 38⅜ cents. The average price of Trenton rock, or Lima-Indiana, petroleum was 88⅝ cents in 1899, as compared with 59.4 cents in 1898, an increase of 29.2 cents per barrel.

There was a decrease in the stocks in 1899, due to shrinkage in the Lima-Indiana district, as the total stocks in the Appalachian field increased by 1,664,588 barrels. At the close of 1899 the total stocks held in the Appalachian and Lima-Indiana fields amounted to 23,997,118 barrels, as compared with 26,967,495 barrels at the close of the previous year. The decrease in 1899 was 2,970,377 barrels. The total amount of petroleum exported from the United States in 1899 was 22,643,439 barrels (951,024,441 gallons), valued at $64,982,249.

1900.—One of the important features in the development of the petroleum industry in the year 1900 is the fact that the production in that year was greater than for any previous year. The total production was 63,620,529 barrels, which amount was greater by 6,549,679 barrels than that of the year 1899. There was a large increase in the output of California, Texas, Indiana, and West Virginia. West Virginia produced 16,195,675 barrels, which was greater than the production of any previous year. There was also an increase in the number of wells drilled and in the stocks. There was an increase in the average price or value of the petroleum at the wells, the price of $1.19 being reached this year, which was the highest since 1877; the average price of Pennsylvania petroleum was $1.35¼ per barrel. The price of Lima-Indiana petroleum advanced from 89¾ to 98¾ cents. The exports of petroleum and its products also showed a considerable gain in quantity and value.

1901.—The production in 1901 was again greater than for any previous year. It was 69,389,194 barrels, an increase of 5,768,665 barrels. There was a most remarkable increase in the production in both Texas and California, which combined amounted to about 8,000,000 barrels. There was a decline in the product of West Virginia amounting to over 2,000,000 barrels. There were also slight declines in New York, Pennsylvania, Ohio, and Wyoming; all the remaining oil producing states showed an increase. The average price of all the petroleum produced in 1901 was 95.7 cents, as compared with $1.191 in 1900, a decrease of 23.4 cents per barrel. The average price of Pennsylvania certificate petroleum was $1.21 per barrel, as compared with $1.35¼ per barrel in 1900, showing a decline of 14¾ cents. The average price of Lima (Ohio) petroleum fell from 98¾ cents in 1900 to 86 cents in 1901. There was also a decline of 37.7 cents in the average price paid for California petroleum and a decline of 76 cents per barrel in the average price of the Texas production. There was an increase in the exports of petroleum and its products (mineral oils), which for the first time exceeded 1,000,000,000 gallons. The total value of the exports was, however, slightly less than in 1900.

On January 10, 1901, an immense gusher was drilled near Beaumont, Tex., and flowed a stream 150 feet high and 6 inches in diameter. Before it was controlled it is estimated to have produced not less than 500,000 barrels, averaging not less than 60,000 barrels per day.

The year was also notable for the organization of an immense number of stock companies in California and Texas, which secured a large amount of capital. Many of them never produced a single barrel of petroleum.

The Boulder field in Colorado was just opening up at the close of the year. It created considerable excitement, and a large amount of capital was invested in stock companies. These investments in most cases resulted in disappointment and a total loss to the investors.

REVIEW OF THE INDUSTRY IN FOREIGN COUNTRIES.

Canada.—Since the year 1862 Canada has produced a considerable quantity of petroleum. The output, however, does not supply the amount necessary for home consumption. In 1902, 11,389,390 imperial gallons of refined petroleum were produced from the crude in Canada, and 13,220,005 imperial gallons of petroleum and its products were imported. An import tax amounting to about 5 cents a gallon is imposed. For a number of years the production in Canada was over 700,000 barrels, but there has been a gradual decline in the output since 1898. The production in 1902 was 520,000 barrels. The main productive territory is situated in Lambton county, Ontario, the two principal districts being Petrolea and Oil Springs.

In quality the petroleum produced in this portion of Canada is very similar to that produced in the Lima-Indiana field, which contains a considerable proportion of sulphureted hydrogen, and it has been successfully refined in former years at Petrolea and in later years at Sarnia. There are other sections in Canada in which more or less petroleum is known to exist, but which have up to the present time yielded little or no output.

In the vicinity of Moncton, New Brunswick, several wells recently completed have produced petroleum in sufficient quantities to be successfully operated. Other localities in which petroleum is known to exist are Gaspé bay in Quebec and near Lake Ainslie in Nova Scotia, but no profitable production has been secured.

There are also indications of petroleum along the northwest coast of Newfoundland. A number of wells have been drilled and petroleum in small quantities has been found, but up to the present time no successful operations have been developed.

In the southwestern portion of Alberta a well was completed during the year 1902 which was reported to have found a considerable flow of petroleum. A well was also drilled near Calgary. There are many localities along the Athabasca river in Athabasca district where petroleum, and especially natural gas, are more or less abundant in surface indications. Although several test wells have been drilled in this section no large quantities of either have been developed.

Peru.—For a number of years this country has produced a considerable quantity of petroleum. The production for 1902 was, in round numbers, 60,000 barrels. The variety is similar to that produced in California, and is inferior in quality to the output of the eastern portion of the United States. The scarcity of good coal along the western coast of South America has added considerable interest to the development of petroleum in Peru. However, the production seems to be on the decline. Outside of the United States, Peru and Canada are the only countries on the Western continent that have produced petroleum in commercial quantities, although it is known to be widely distributed in Argentine, Brazil, Colombia, Cuba, Ecuador, Mexico, Trinidad, and Venezuela. In most of these countries there are local springs and shallow wells, worked generally in a very crude manner by the natives, which have produced a small amount of crude petroleum.

Russia.—For the first time in eight years, Russia in 1902 showed a decreased output of crude petroleum. The decrease from the output of 1901 amounted to 4,628,511 barrels, a falling off of about 5 per cent. The principal reasons for the decline seem to have been the want of organization among the producers, insufficient means of storage and transportation, and the taxes imposed by the Government upon certain territory.

A number of large spouting wells were drilled during the year, one of the largest of which was on the Rothschild plot, No. 25, at Romany, Bibi Eibat district. For a time this well yielded 80,000 barrels per day. Another large well near by produced at the rate of 100,000 barrels per day. The depth at which large spouting wells are secured is gradually increasing, adding largely to the expense. Often several years are consumed in completing one of these very deep wells, which require many feet of casing, beginning with a size as large as 26 inches in diameter and ending with a diameter 10 to 12 inches. In some of them the wrought iron pipe and casing used weighs as much as 90 tons, which, together with the time consumed in drilling, entails a cost of from $15,000 to $20,000.

During the year a new field was discovered by the drilling of a well near Berekei station, 170 miles northwest of Baku. The Grosni field, 500 miles north of Baku, has produced considerable petroleum for the last five years. The greater portion, or 95 per cent, of the petroleum continues to be produced from an area of about 10 square miles in the Apsheron peninsula near Baku. The following table shows the yearly production of petroleum in Russia, by districts, since 1889:

TABLE 42.—*Production of crude petroleum in Russia, by districts: 1889 to 1902.*

[Barrels of 42 gallons.]

YEAR	Total.	Balakhani.	Sabuntchi.	Romani.	Bibi Eibat.	Binagadi.	Grosni.
1889	23,592,163	8,424,364	12,995,012	....	2,172,787	......	......
1890	27,660,953	7,742,995	17,525,131	189,022	2,203,802	......	......
1891	33,565,819	9,067,863	19,992,379	1,585,312	2,920,257	......	......
1892	35,026,144	7,028,973	18,916,516	5,017,286	4,066,369	......	......
1893	39,703,304	7,070,101	17,883,692	8,943,313	5,806,198	......	......
1894	36,375,428	7,217,054	17,485,232	7,542,922	4,130,220	......	......
1895	46,140,174	8,258,961	18,500,198	13,619,629	5,761,376	......	......
1896	47,220,633	10,470,315	18,664,322	9,546,250	8,539,746		
1897	54,399,568	11,774,479	20,406,918	11,821,815	7,642,356		2,754,000
1898	61,609,357	12,921,001	22,396,000	12,292,016	11,800,340		2,200,000
1899	65,954,968	13,788,013	27,701,965	11,834,548	9,704,779	19,613	2,906,050
1900	75,779,417	14,967,598	30,298,182	13,788,820	13,110,092	48,801	3,658,924
1901	85,168,556	14,139,716	35,414,097	15,297,031	16,030,998	50,196	4,190,918
1902	80,540,045	12,185,354	32,071,908	16,800,000	15,298,200	58,583	4,125,999

The total production of petroleum in Russia, as compared with that of the United States, from 1894 to 1902, inclusive, together with the percentages of gains or losses for each year, as compared with the previous year, and the production of Russia in percentage of the production of the United States, are shown by the following table:

TABLE 43.—*Comparative production of crude petroleum of Russia and the United States: 1894 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Barrels of 42 gallons.]

YEAR	UNITED STATES			RUSSIA			Production of Russia in percentage of production of United States.
	Production	Gain or loss.	Per centage of gain or loss.	Production.	Gain or loss.	Per centage of gain or loss.	
1894	49,344,516	....	....	36,375,428	....	....	73.7
1895	52,892,276	3,547,760	+7.19	46,140,174	9,764,746	26.8	87.2
1896	60,960,361	8,068,085	+15.25	47,220,633	1,080,459	+2.3	77.4
1897	60,475,516	484,845	0.80	54,399,568	7,178,935	+15.2	89.9
1898	55,364,233	5,111,283	8.45	61,609,357	7,209,789	+13.3	111.3
1899	57,070,850	1,706,617	+3.08	65,954,968	4,345,611	+7.05	115.7
1900	63,620,529	6,549,679	11.48	75,779,417	9,824,449	+14.9	119.1
1901	69,389,194	5,768,665	+9.07	85,168,556	9,389,139	+12.4	122.7
1902	88,766,916	19,377,722	+27.93	80,540,045	4,628,511	5.4	90.7

¹Does not include 508,536 barrels produced but not marketed.

The following tabular statement gives the shipments of crude and refined petroleum from the ports of Batum and Novorossiisk on the Black sea to foreign countries and to Russian ports near by, in 1902 and 1901, as reported by Mr. James C. Chambers, United States consul at Batum, Russia:

TABLE 44.—SHIPMENTS OF RUSSIAN PETROLEUM FROM BLACK SEA PORTS: 1902 AND 1901.

[United States gallons.]

TO—	TOTAL.		REFINED.		SOLAR AND DISTILLATE.¹		LUBRICATING.		CRUDE AND RESIDUUM.	
	1902	1901	1902	1901	1902	1901	1902	1901	1902	1901
Total shipped	461,762,050	466,249,580	354,642,656	357,859,645	45,575,800	48,215,740	46,245,900	39,649,525	15,569,600	14,564,220
Total exported	422,488,925	428,687,210	319,641,670	328,732,460	45,372,800	48,135,010	44,645,400	38,170,820	12,818,055	13,269,920
Africa	....	297,120	....	297,120						
Austria-Hungary	5,743,225	7,381,560	3,973,690	3,429,580		2,386,695	1,768,035	1,566,280	1,500	
Belgium	23,016,250	21,563,045	9,729,645	10,127,250	530,380	515,640	8,747,840	7,550,295	3,438,385	3,311,210
Bulgaria	2,787,740	2,851,950	2,733,300	2,787,050			49,660	53,150	4,750	11,750
Cochin China	....	999,640	....	999,640						
China	7,625,250	21,320,040	7,624,750	21,320,040			250		250	
Egypt	15,852,345	13,759,075	15,536,655	13,569,525			277,690	178,560	38,000	11,000
United Kingdom	113,994,905	87,017,195	82,690,895	55,782,960	20,138,760	20,500,010	9,167,745	8,197,845	1,998,870	2,526,780
France	41,676,200	38,467,800	958,200	1,544,190	21,242,275	21,780,745	14,871,675	9,907,420	2,601,110	2,510,015
Germany	35,799,865	25,193,780	24,136,725	12,871,280	....	....	9,795,120	9,119,960	1,868,250	2,199,540
India	42,742,150	53,661,390	42,699,060	53,621,390	....		43,150	40,000		
Italy	9,226,325	10,835,555	7,066,715	8,277,135	2,740		170,400	199,650	1,987,400	2,358,770
Japan	5,067,850	4,050,000	5,067,850	4,050,000						
Java	1,471,100	5,832,070	1,471,300	5,832,070						
Malta	1,841,730	1,267,975	1,841,730	1,267,975						
Netherlands	12,807,040	6,487,285	12,154,540	6,150,835			252,500	337,450		
Philippines	2,257,400	1,965,350	2,257,400	1,965,350						
Portugal	2,202,100	1,116,650	2,202,100	1,116,650						
Roumania	228,600	661,500	158,800	549,180			68,300	111,450	1,500	800
Siam	....	173,000	....	173,000						
Spain	269,735	1,258,915	....	....			269,585	602,020	150	651,895
Suez Canal²	61,386,715	81,716,255	61,386,715	81,716,255						
Turkey	29,514,600	29,476,500	29,303,400	29,258,960			125,400	141,850	85,800	78,750
All other countries	7,417,580	2,067,010	6,390,510	1,989,160			48,050	78,200	979,020	[illegible]
Russian ports	39,273,095	41,562,930	34,900,985	29,127,185	....	19,730	1,591,300	3,082,105	2,691,625	1,254,395

¹"Solar and distillate" means gas oil to the United Kingdom and distillate to France.
²To unknown ports beyond the canal, the shipments being to book.

About 80 per cent of the entire petroleum production is marketed in the interior of Russia by way of the Caspian sea and the Volga river. In 1902 the quantity amounted to 2,054,990,000 gallons, of which 1,693,420,000 gallons, or over 82.4 per cent, was residuum used for fuel and 107,995,000 gallons, or 5.3 per cent, was crude petroleum. Only 12.3 per cent of the illuminating and lubricating products was marketed in the great inland portion of Russia.

The average price of crude petroleum at the wells at Baku in 1902 was 6.65 kopecks per pood, or 3.42 cents for 5 gallons, or 28¾ cents per barrel, as compared with 8.25 kopecks per pood, or 32¾ cents per barrel, in 1901.

WORLD'S PRODUCTION.

One of the conspicuous features of the world's production of petroleum in 1902 was the remarkable increase in the output of the inferior grades in the United States. Of the world's production the United States produced 47.9 per cent in 1902. In 1901 it produced 41.84 per cent. Another very important feature was the decline in the Russian production which, in 1902, amounted to 43.50 per cent of the world's production, as compared with 51.38 per cent in 1901.

The United States and Russia in 1902 produced 91.44 per cent of the world's production, in 1901 they produced 93.22 per cent, and in 1900 their production was 94.11 per cent.

The following table gives the production of crude petroleum in all the known countries of the world, together with the percentage for each during 1902, 1901, and 1900:

TABLE 45.—*World's production of crude petroleum: 1900 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States" 1902.]

[Barrels of 42 United States gallons.]

COUNTRY.	1902		1901		1900	
	Quantity.	Per cent of total.	Quantity.	Per cent of total.	Quantity.	Per cent of total.
Total	185,151,089	100.00	165,773,361	100.00	148,114,975	100.00
United States	[1]88,766,916	47.94	69,389,194	41.84	63,620,529	42.95
Canada	520,000	0.28	572,500	0.35	692,650	0.47
Peru	60,000	0.03	72,261	0.04	102,976	0.07
Russia	80,540,045	43.50	85,168,556	51.38	75,779,417	51.16
Galicia	4,142,160	2.24	3,251,544	1.96	2,346,505	1.58
Sumatra, Java, and Borneo	5,860,000	3.17	3,058,700	1.84	1,967,700	1.33
Roumania	2,059,930	1.11	1,095,160	0.66	1,628,535	1.10
India	1,617,363	0.87	1,430,716	0.86	1,078,264	0.73
Japan	1,193,000	0.64	1,100,000	0.67	528,000	0.36
Germany	353,675	0.20	313,630	0.19	358,297	0.24
Italy	12,000	......	10,100	......	12,102	0.01
All other countries	26,000	0.02	20,000	0.02	......	......

[1] Does not include 508,386 barrels produced but not marketed.

There was a steady increase in the world's production of petroleum during the last three years, which would be much more marked in 1902 were it not for the fact that the Russian production showed a decrease of 4,628,511 barrels in that year. The total increase in the world's production in 1902 amounted to 11.1 per cent as compared with 1901 and to a little over 25 per cent when compared with that of 1900.

DESCRIPTIVE.

Origin.—Much speculation and controversy have been aroused among chemists and geologists as to the origin of petroleum, but no complete and satisfactory solution of the problem has yet been presented. Numerous theories have been advanced as to the original source of the carbides and hydrocarbons and their combinations, entering into the formation of petroleum, and many scientists of note have a particular theory, but there appears little possibility of reaching an agreement in the matter in the near future. Experiments in the laboratory have been made so as to combine the elements artificially and the resultant, in most instances, has been a liquid, which in appearance and composition is very similar to the natural petroleum. Petroleum has also been produced by the distillation of shales, and there are many upholders of the claim that the formation of petroleum is due to the natural distillation by internal heat of the shales and hydrocarbons found in the earth's crust. Its origin is one of the unsolved problems.

The various theories advanced by men of science to account for the formation may be in most cases narrowed down to two, each of which has found numerous supporters. These are—first, its physical origin by the distillation of organic matter in the sedimentary strata, either animal or vegetable; second, its chemical origin from inorganic matter or direct production by the decomposition of carbides through the action of steam deeply buried below all sedimentary strata.

In all of the known fields of the world the occurrence of petroleum is limited to comparatively small areas. The area of the same strata in which the petroleum is not found invariably covers a vastly greater area than the portions that are productive. This is the case also in some instances where the structural conditions may favor its accumulation, and the surrounding slates and shales are similar. When productive rocks can be traced to their outcrop there is invariably no trace of petroleum or asphaltum to be found in them. The wells drilled outside of these favored localities usually find no trace of petroleum or natural gas, although numerous sands may have been pierced which are productive elsewhere and are sufficiently open and porous to be receptacles.

Chemical and physical properties.—Petroleum, in both its liquid and solid forms, is largely made up of carbon and hydrogen. It ranges from 77° Baumé, or 0.6763 specific gravity, in the case of the lightest naphtha, condensed naturally from natural gas, up to between 1.1 and 1.3 in its more dense and solid form, such as natural asphalt, which usually contains from 50 to 80 per cent of carbon, 6 to 10 per cent of hydrocarbon, and 8 to 10 per cent of sulphur. These solid forms are widely distributed, vary greatly in composition, and are usually associated, in varying proportions, with more or less silica and carbonate of lime.

General structural conditions influencing occurrence.—There is a vast difference in the character of petroleum produced in the United States and in foreign countries, and a great variety in the character of the strata which contains it. The infiltration of the petroleum into different sands and limestones has had much to do with imparting to it the varied physical and chemical properties. However, the structural conditions of these strata and the position they must occupy in order to bring about a concentration of the petroleum are similar in all of the productive fields. Its occurrence in small quantities in strata where the conditions necessary for concentration are wanting has in many instances been the cause of financial loss and disappointment.

Geological occurrence of petroleum and natural gas in the United States.—The intimate association of the liquid and gaseous hydrocarbons has made it difficult to separate them when one or the other is discussed. The great deposits of petroleum in the Appalachian field are in a series of sand rocks reaching up from the Lower Devonian to the Upper Barren measures or Monongahela formation, less than 100 feet above the Pittsburg coal, and embraces not less than 50 distinct horizons. The greater portion of the production, however, comes from the Catskill division, Upper Devonian, which group is petroleum bearing from northern Pennsylvania, near the northern portion of Venango county, southwest to the Little Kanawha river in West Virginia. In Warren, McKean, and Elk counties, Pa., productive sands are found below this group and are largely productive. They extend into south central New York and belong to the Middle Devonian formation. The overlying Berea and the Pocono or Big Injun and Lower Carboniferous sands are above the Catskill group in the geological scale, and are largely productive in West Virginia, southeastern Ohio, and to some extent in eastern Kentucky. The highest series of productive strata in the region east of the Mississippi river are composed of the sands of the upper and lower coal series, which are productive in southwestern Pennsylvania, West Virginia, and southeastern Ohio. The sandstone series of the Appalachian division, in 1902, produced 36 per cent of the total production.

Over 85 per cent of the petroleum produced in the United States from the beginning of production up to the close of 1902 also came from the sandstone strata of the Appalachian field. Here there are 40 distinct horizons in 3,300 feet of measures, and the individual beds of sandstone vary from 2 to 120 feet in thickness and differ in texture from an open light colored sand with layers of pebbles, which is very prolific, to sand of a close and hard texture, which it is necessary to torpedo in order to secure production. The highest productive sand of any practical value in the geological scale is the Mahoning, or Dunkard, sand of Pennsylvania or the first Cow Run sand of Ohio; the lowest is the Kane sand in Elk and McKean counties, Pa., and the sands of western New York. The Venango county sands are made up of a series of from four to six distinct beds, separated by strata of slate and shale. These sands generally contain layers or beds of white pebbles, often capped by a hard siliceous portion and separated by beds of shale and slate ranging in color from black to red. In Venango county the series has an average thickness of 300 feet from top to bottom, increasing to 430 feet at McDonald, in Allegheny county, Pa., and in portions of West Virginia. There is a general thinning out of this group toward the west and it thickens toward the east. They are generally known as the white-sand group.

Most of the sands below, and including the Speechley and Bradford sands, are darker in color and finer in texture than those above and are known as the dark-sand group. All of them consist of distinct layers, invariably capped by strata of dark slate or shale, which vary in thickness and allow the layers of sand to approach much nearer to each other in some localities than in others.

The source of the petroleum in the Lima-Indiana field is the Trenton limestone, which has produced very largely since first discovered in this field in 1885. From its first discovery to the close of 1902, this formation has produced 9 per cent of the total output of the United States. It is productive only in the region which embraces northeastern Ohio and central Indiana, known as the Lima-Indiana field. This limestone, which is usually over 500 feet in thickness, has a series of porous streaks embedded in the regular strata, and these streaks differ in composition from the great mass, being a dolomite which has replaced the carbonate of lime with crystals that are smaller than the carbonate crystal, and which do not, therefore, fill up the original space in the process of replacement. This changed and open conditions of the strata which invariably contain the petroleum (often associated with large deposits of salt water) are found at intervals of from 20 to 325 feet in extreme cases from the upper surface of the limestone.

The Trenton limestone is a remarkably regular and clearly defined deposit. The change from the Utica black slate, which caps it, to the rock is distinct and easily recognized by the driller.

The horizon in which petroleum is found in Kansas and Indian Territory corresponds to that of the salt sand group in West Virginia, located in the lower portion of the Pottsville group, resting on the Mississippian limestone, which is in a general way equivalent to the subcarboniferous limestone of southwestern Pennsylvania and West Virginia. All the remaining production west of the Mississippi river is secured from strata that are much more recent, reaching from the Permian to the Quaternary. These newer productive measures consist of much thicker strata—a thickness of 15,000 feet is recorded in localities—and are made up of the recent sedimentary deposits. The several pools west of the Mississippi river produced 37.61 per cent of the output in 1902.

Character and composition of petroleum produced in the United States.—The Mississippi river separates the petroleum fields of the United States into two great divisions. The fields east of this line, to an almost universal extent, have developed petroleum with a paraffin base, while the fields to the west have, with a few exceptions, produced petroleum with an asphalt base. Crude petroleum with a paraffin base is generally much lighter and is much more valuable, owing to the greater quantity and superior quality of the naphthas and illuminating and lubricating derivatives it yields, as well as the paraffin, which is secured from the heavier distillates after the lighter products have been extracted.

On the other hand, petroleums with an asphalt base, in most cases, yield only a comparatively insignificant quantity of naphtha and a much smaller proportion of illuminating and lubricating products, which are of inferior quality, while the remaining distillates are principally valuable for fuel and as asphalts. The asphalt petroleums are also usually much heavier and are more difficult to transport by means of pipe lines, so generally applied in the fields producing paraffin petroleum.

These conditions restrict the market for asphalt petroleum, so that in general it is consumed as fuel oil, as distillates for enriching manufactured gas, and as asphalt. There are several exceptions to this generalization, however, as petroleum, in comparatively small amounts, is found in portions of Kansas, Texas, Indian Territory, Colorado, and California that yields refined products little inferior to the best grades of paraffin oil.

The products obtained by the refining of the Appalachian petroleum, and of oils from the other fields, are given below, in percentages, in a series of statements representing general results. There are marked differences in the composition of crude petroleum and in methods of refining. These methods are often varied, to a certain extent, to meet the demands of the market.

The following statement gives the general average products secured from the combined petroleum output of the Appalachian and the Lima-Indiana fields, which in 1902 represented 62.38 per cent of the total output of the United States:

Average products from the petroleum produced in the Appalachian and Lima-Indiana fields: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	13.9
Illuminating oils	58.7
Lubricants and heavy oils	8.2
Residuum (paraffin 3.42 per cent)	12.8
Loss from uncondensed light products and water	6.4

The following statement for the Appalachian field gives the average production obtained from the crude petroleum produced in western Pennsylvania, West Virginia, and southeastern Ohio:

Average products from petroleum produced in the Appalachian field: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	20.1
Illuminating oils	61.4
Lubricants and heavy oils	7.1
Residuum (paraffin 3.10 per cent)	6.3
Loss from uncondensed light products and water	5.1

For many years only a comparatively small proportion of the petroleum produced from the Trenton limestone, in the Lima-Indiana field, was refined. This was owing to the presence of a large amount of sulphureted hydrogen, which seemed to be thoroughly combined with the carbon and hydrocarbon which constitute the main elements of petroleum. By double refining the petroleum, however, and the oxidation of the sulphur—the black oxide of copper being used—the refiner has succeeded in producing an article which can scarcely be distinguished from the products of Pennsylvania crude petroleum, although the percentage of refined products secured is smaller.

The following is a fair average result of the distillation of crude petroleum from the Lima-Indiana field, which is located in Ohio near its northwestern extremity, reaching over into Indiana, the average specific gravity being 38.5° Baumé:

Average products from petroleum produced in the Lima-Indiana field: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	10.9
Illuminating oils	48.8
Metal and heavy oils	17.2
Residuum and loss	23.1

There are some refined samples which contain a small fraction of a per cent of sulphur, which does not in any way manifest itself in the process of combustion, while in others all but the faintest trace of sulphur must be removed. The original crude oil from the Lima-Indiana fields contains nearly 0.56 per cent of sulphur. The amount of sulphur found in the Pennsylvania petroleum varies from 0.025 to 0.002 per cent. Nearly all of the sulphur in the Lima-Indiana petroleum goes over when distilled, being found in both the light and heavy distillate, and it is necessary to oxidize the sulphur in order to remove it.

The gravity of naphtha varies from 90° to 60° Baumé, the lighter portions being too unstable for an accurate statement owing to their tendency to change from a liquid to a gaseous condition upon a slight rise in the temperature or a fall in the barometer. The gravities of refined oil distillates range from 50° to 44° Baumé; that of residuum from 25° to 15°. There is usually left in the bottom of the still, after the liquid is drawn off, from 1 to 1.5 per cent of the original charge. This remains in the form of a compact cellular solid, known as "coke," which is almost pure carbon, and which is usually disposed of to parties who manufacture carbon pencils for electric arc lights. During the process of distillation the proportion of these products is varied, to meet the demand of the market, by prolonging or shortening the intervals of cutting off from one variety and beginning on the other. The lighter products are always the first to condense, then come those with an average density, and the heaviest last.

The quality of a portion of the petroleum produced in Kansas and Indian Territory in many respects resembles Pennsylvania petroleum, although the gravity is lower. Separated by intervals of dry or undeveloped territory, there are a number of productive pools, which yield petroleum of a gravity varying from 36° to 28° Baumé, although there is a considerable portion as heavy as 18° to 20°. Nearly the entire production of the lighter grades is sold to the refineries at Neodesha, where an excellent water-white illuminating petroleum is manufactured.

In these fields the lighter products amount to about 45 per cent of the total yield. A considerable portion of the heavier products is marketed as a gas enricher or as a fuel oil. The following may be taken as a fair average of the products secured from the petroleum of 36° Baumé in the Kansas field:

Average products from petroleum produced in the Kansas field: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	18.0
Illuminating oils	30.0
Heavy distillate	25.0
Residuum and loss	27.0

The crude petroleum found in the Florence field, Colo., is of good quality, and comes principally from the Florence pool. This pool produces a petroleum of 31° Baumé, and contains about 10 per cent naphtha and gasoline, 36 per cent illuminating oil, and 54 per cent residuum and loss.

During 1902 a remarkably pure petroleum, of 43° Baumé, was developed in a small pool, near Boulder, 30 miles north of Denver. This petroleum gave the following remarkable analysis when refined:

Analysis of petroleum developed near Boulder, Colorado: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	17.0
Illuminating oils	41.0
Signal oils	7.5
Lubricating and cylinder oils	32.0
Loss in refining	2.5

There are two or more different varieties of crude petroleum found in Texas. A comparatively small quantity produced in the Corsicana district is a superior oil, as the following analysis will show:

Analysis of petroleum produced in the Corsicana (Tex.) district: 1902.

PRODUCT.	Per cent.
Total	100.0
Naphthas	13.8
Kerosene (illuminating product principally)	54.5
Lubricating oils and residuum	31.7

Its specific gravity is 0.82, equal to 40° Baumé. In the year 1902 about 96 per cent of the Texas production was an inferior grade of petroleum, containing 1.4 to 1.8 per cent of sulphur, and having a specific gravity of nearly 0.92, equal to 22° Baumé. This is satisfactory as a fuel product, and a very large part of it is consumed as such. A comparatively small yield of the lighter products is secured in refining. According to Prof. C. A. Mabery, at from 145° to 200° only 4 per cent passed over as naphtha at 46° Baumé, or 0.7954 specific gravity; and at from 200° to 250° only 11 per cent passed over at 35° Baumé, equal to 0.8484 specific gravity. This latter distillate represents the illuminating product, which is much heavier than that usually secured in other parts of the United States, where it ranges usually from 0.800 to 0.815 in specific gravity.

Dr. Boverton Redwood, of London, England, records the following results in a test of a sample of illuminating petroleum refined at Port Arthur, Tex., burned in a lamp with a Hinks duplex burner; and from these results he formed the opinion that the oil represented by the sample would be found, in practical use, a thoroughly satisfactory illuminating agent:

Specific gravity at 60° F., 0.823.
Flash point (Abel test), 83° F.
Color, prime white, 2.6.
Odor, good merchantable.
Sulphur, 0.1 per cent.
Illuminating power, initial, 26.
Illuminating power, after three hours, 24.8.

Illuminating power, after six hours, 24.7.

Illuminating power, average for six hours, 25.2.

Diminution in illuminating power during six hours, 5 per cent.

Consumption of oil per hour, 1,193 grains.

Consumption of oil per candle hour, 47.4 grains.

The composition of Pennsylvania, Lima (Ohio), Beaumont (Tex.), California, and Russian crude petroleum is as follows:

Composition of American and Russian crude petroleum.

ELEMENTS.	Pennsylvania (1).	Ohio (Lima) (2).	Beaumont (3).	Beaumont (4).	California (5).	California (6).	Russian (7).
Carbon	86.10	85.00	84.60	85.03	86.93	84.00	86.60
Hydrogen	13.90	13.80	10.90	12.30	11.82	12.70	12.30
Sulphur	0.06	0.60	1.63	1.75	....	0.40	......
Oxygen and nitrogen	......	......	2.87	......	1.25	2.90	1.10
Loss in treatment with excess of H_2SO_4	21.00	30.00		30.00	......	......	......

Analyses by—(1) Engler; (2) Mabery; (3) Denton; (4) Richardson and Wallace; (5) Peckham; (6) Salathe; (7) Redwood.

In some analyses the sulphur in the Beaumont petroleum is placed as high as 2 per cent. For the most part, however, it is not combined chemically, but is merely dissolved, and can, therefore, be more easily separated than that found in the Lima-Indiana petroleum.

Wyoming produced comparatively an insignificant quantity of a very high-grade lubricating petroleum, which is partially distilled and filtered under pressure before it is put upon the market.

There are a number of grades of crude petroleum produced in California, ranging from natural naphtha, with a specific gravity of 65° Baumé, to heavy black tar, with a gravity as low as 14° Baumé.

About 80 per cent is made up of the very heavy petroleum which finds a market principally as fuel. The portion that is refined does not produce such light products as the eastern oils; they are all heavier, as they have a larger proportion of carbon to that of hydrogen in their composition. Largely for the same reason, they do not have the same illuminating effect when burned in the ordinary lamp. To make them acceptable as illuminating oils they are often mixed with the eastern products.

The following analyses are of a number of varieties of petroleum produced in southern California, as determined by Prof. F. Salathe, Ph. D.:

Analyses of petroleum produced in southern California: 1902.

LOCATION.	Degrees Baumé.	Naphtha.	Illuminating distillate.	Gas distillate.	Lubricating distillate.	Asphalt and loss.
Sespe	25.80	7.00	19.80	25.00	35.80	12.40
Torrey Canyon	27.00	9.20	21.50	26.00	30.30	13.00
Adams Canyon	24.00	5.20	24.50	17.30	46.00	7.00
Los Angeles	14.20	Trace.	6.00	17.50	51.50	25.00

Near Coalinga, in Fresno county, a petroleum is found in considerable quantity that is much lighter than the output of other parts of the state, its gravity ranging from 35° to 30° Baumé. Its composition is as follows:

Analysis of petroleum produced in Fresno county, California: 1902.

PRODUCT.	Per cent.
Total	100 to 100
Naphtha	16 to 20
Kerosene	47 to 48
Heavy fuel oil	13 to 10
Benzine tar, and loss	22 to 22

The general increase in the production of the inferior grades of petroleum during the last three years, and the slight decrease in the production of the higher grades, are among the notable features in the general course of development. The very recent and large production in Texas, Louisiana, and California is one of the important facts in the growth of this industry, and indicates that in the future the refiner will be called upon to supply standard goods from inferior stock.

The calorific value of petroleum. The calorific or heat producing properties of petroleum are measured by the pounds of water that a given weight will evaporate at a temperature of 212° F. when there is no heat lost. It has also been determined that the heating energy necessary to evaporate 1 pound of water at 212° F. would raise the temperature of 966 pounds of water 1° F. The unit used is the heat necessary to raise the temperature of 1 pound of pure water 1° F. at or near 39.1° F., which is known as the British thermal unit, generally expressed as "B. T. U." The French thermal unit, the "calorie," is that quantity of heat required to raise the temperature of 1 kilogram (2.2046 pounds) of water 1° C. The "B. T. U.," therefore, is equal to 0.252 calorie. The "pound calorie" is sometimes used by English engineers; it is the quantity of heat necessary to raise the temperature of 1 pound of pure water 1° C.; 1 pound calorie equals nine-fifths "B. T. U.," or 0.4536 calorie.

It is remarkable that petroleums of different specific gravity and chemical composition, and coming from widely separated localities and countries, have calorific values so nearly equal, as indicated by the number of pounds of water theoretically and actually evaporated per pound of petroleum consumed. In giving the test of boilers, under the head of actual pounds of water evaporated at and above 212° F., they are often credited with the results of special tests made when the boilers and the surrounding appliances were in perfect condition; therefore, in practice, the results will in many cases be lower than the figures quoted.

The specific gravity, British and French calorific equivalents, and the actual and theoretical number of pounds of water evaporated from and at 212° F. per pound of petroleum consumed are shown in the following tabular statement:

Comparative calorific value of fuel petroleum from the principal fields of the United States and from Russia.

LOCALITY.	Specific gravity per cent.	Degrees Baumé.	British thermal unit.	French calorie.	Actual pounds of water evaporated at 212° F. in boilers.	Theoretical pounds of water evaporated at 212° F.
Pennsylvania, crude	0.8291	40	19,800	11,000	14.85	19.75
Pennsylvania, crude, heavy	0.8860	28	20,736	11,520	16.00	21.46
Ohio, Lima	0.8383	37	19,900	11,055	15.45	20.60
Texas, Beaumont	0.9210	22	19,480	10,816	14.80	20.16
Texas, Sour Lake	0.9333	20	18,960	10,505	14.40	19.62
Louisiana, Jennings	0.9090	24	19,230	10,675	14.60	20.01
California, Bakersfield	0.9589	16	19,000	10,555	14.30	19.67
Russia, Baku	0.8805	29	20,550	11,420	15.50	21.28

There is a wider variation in the fuel value of the various kinds of bituminous coal than there is in the different grades of fuel petroleum. The following tabular statement gives the water evaporated per pound of the different varieties of bituminous coal and the number of barrels of petroleum that will do the same work under boilers having modern arrangements for efficiency:

The comparative fuel value of petroleum and bituminous coal.

FUELS.	Pounds of water evaporated at 212° F. per pound of combustible.	Barrels of petroleum to equal 1 ton of coal.	Comparative cost of coal per ton on basis of petroleum, at $1 per barrel.	
			Gross cost.	Less 10 per cent, owing to economy in handling petroleum.
Petroleum, 16° to 40° average	15.3	…	…	…
Pittsburg, Pa., lump	10.0	4.1	$4.10	$3.69
Pittsburg, Pa., slack	7.5	3.1	3.10	2.79
Pocahontas, W. Va., lump	10.5	4.3	4.30	3.87
Cumberland, Md., lump	10.0	4.1	4.10	3.69
Ohio Hocking Valley, lump	8.0	3.3	3.30	2.97
Indiana, block, lump	9.5	3.9	3.90	3.51
Indiana ordinary, run of mine	7.8	3.2	3.20	2.88
Kansas, average, run of mine	7.8	3.0	3.00	2.70
Indian Territory, average	7.5	3.1	3.10	2.79
British Columbia, Nanaimo	7.3	3.0	3.00	2.70
Washington, Carbon Hill	6.2	2.5	2.50	2.25

The final column gives the price per ton of coal that would be paid to equal petroleum at $1 per barrel. The poorer the quality of the coal the fewer the barrels of petroleum required to equal the heating effect.

Liquid fuel for marine purposes. The development in the last two years in Texas, Louisiana, and California of large fields of petroleum specially adapted for fuel, with the probabilities of increased production in these localities in the near future, has added to the interest felt in the practical solution of the fuel problem. The possibility of the successful and economical use of liquid petroleum in the Southwest and West has been fully demonstrated in its application to locomotives and stationary engines, as well as to a vast number of manufactories that require a large supply of fuel.

In eastern Europe and southern Asia, along the path of the great ocean commerce and on the waters of the Black and Caspian seas, its use is increasing. Russia and Borneo, and, to a less extent, Sumatra and Java, furnish the liquid fuel in these far-off countries. At Singapore a central supply depot of considerable magnitude has been established within the last few years. There are smaller supplies stored at Suez, Bombay, Calcutta, Hongkong, and Yokohama. There are a number of large steamers employed on the Gulf of Mexico and the Pacific coast, some of which have used liquid fuel for a number of years and have fully demonstrated its superiority. The number of petroleum burning steamers is rapidly increasing.

The utilization of the entire energy in petroleum will be accomplished only when it is mixed with the atmosphere under high pressure and exploded in the cylinder direct, in which case the costly, troublesome, and wasteful boiler will no longer be necessary.

During the year 1902 the U. S. Navy made some very interesting experiments with petroleum as a fuel, which were conducted by a special division of the Bureau of Steam Engineering known as the Liquid Fuel board, under the direction of Rear-Admiral George W. Melville, Chief Engineer U. S. Navy.

Character of lubricating petroleum in the United States. Natural lubricating petroleum of the finest grade is often found in the higher strata of the productive series at shallow depths below the earth's surface. It is usually associated with more or less salt water, usually ranges from 32° to 34° Baumé, is not affected, so far as fluidity is concerned, by a temperature of zero or below, and commands a higher price than any other variety of natural petroleum.

The petroleum lubricants differ according to the crude petroleum from which they are made. The chemical composition of crude petroleum from different localities is not the same, showing either that the materials used in its preparation in the earth vary, or that by filtration through different strata different combinations are formed. The largest production of natural crude lubricating petroleum is from the neighborhood of Franklin, Pa., which has long been celebrated for the production of the finest natural lubricating petroleum found in the world.

There is also a large amount of lubricating oil manufactured from Pennsylvania crude petroleum, some of which is mixed with the natural product. No other lubricating petroleum is equal to that produced in the Appalachian field. Its reputation is world wide. Many railroads and steamship lines use it exclusively; the railroads using it in the United States operate 97 per cent of the total mileage. Nearly 2,000,000 barrels were exported in 1902.

Early development of petroleum in the United States.—Years ago the process of distilling natural mineral hydrocarbons was being perfected and vigorously pushed in the Eastern states, and cannel shale was imported from England and distilled at refineries near Boston and Portland. On the Allegheny river near Freeport, Armstrong county and Darlington, Beaver county, Pa.; in Ohio, West Virginia, western Kentucky, and elsewhere in this country and in Europe, there were refineries or distilling plants endeavoring to supply the demand for an efficient and cheaper lighting oil. The high price, however, prevented its universal introduction. The tallow candle was almost the universal source of artificial light before the great natural deposits of petroleum were known.

The earliest records of the travelers who first penetrated the wilderness of southwestern New York, northwestern Pennsylvania, southeastern Ohio, and south central Kentucky mention the existence of petroleum and natural gas; and the early explorers were guided to these localities by the Indians, who regarded the phenomena with religious superstition. On Oil creek, Pa., there were a number of localities where globules of petroleum and bubbles of natural gas constantly came to the surface of the water. The remains of pits that were cribbed in a crude manner were noted by the early explorers in numerous localities, extending from the mouth of Oil creek to Titusville.

From 1848 to 1856 Mr. Samuel M. Kier, of Tarentum, Pa., bottled the petroleum obtained from his salt well and sold it under the name of "Seneca oil," which name it acquired from the Seneca Indians in New York state, who were early acquainted with its medicinal virtues. The partial refining of the petroleum found in the salt-brine wells at Tarentum was accomplished by Mr. Kier about the year 1857. Owing to the rude method of refining and the poorly constructed lamps of that day there were many bitter complaints of the odor and smoke of the new illuminating oil when it was first tried.

During the years 1853 to 1860 there were four large plants erected near Freeport, Pa., on the Allegheny river, near the mouth of the Kiskiminitas river, for the distillation of a cannel slate, which in this locality varies from 2½ to 7 feet in thickness and forms the roof of the lower Freeport coal strata.

In 1856, after many failures, a plant at Freeport succeeded in producing an oil that burned with a bright light and was free from odor and smoke. Its introduction was accompanied with difficulty, owing to the dangerous and highly explosive "burning fluid" that was at that time in use. At this period there were also cannel coal distilling plants at Darlington, Beaver county, Pa., Canfield, Mahoning county, Ohio, Cannelton, W. Va., and Cloverport and Maysville, Ky. In Massachusetts parties who had formerly been engaged in the manufacture of whale oil commenced to manufacture a paraffin oil from cannel slate (called boghead mineral) imported from Scotland. About this time small quantities of petroleum were collected by Mr. J. D. Angier, on an island near the mouth of Pine creek on Oil creek, Pa., about 1½ miles below Titusville, from pits arranged one above the other, and by others who used blankets and temporary dams.

On the 30th day of December, 1854, the Pennsylvania Rock Oil Company was organized, based upon the purchase of 105 acres at the junction of Oil and Pine creeks, near Titusville, Pa., and the certificates of incorporation filed at New York city and Albany. In April, 1855, the elaborate and favorable report of Prof. B. Silliman, of Yale College, was made public, adding largely to the prospective value of the original company. The eastern capitalists hesitated to subscribe for the stock, as they were uncertain whether a company under the laws of New York could hold land in fee in Pennsylvania. To overcome this difficulty a new company, which retained the original title, increasing the capital stock to $300,000, was organized under the laws of Connecticut, September 18, 1855. A deed was executed to Ashel Pierpont and William A. Ives, of New Haven, who gave bond for the value of the property and promptly leased it for ninety-nine years to the new company.

On December 30, 1857, the property was leased to Edwin E. Bowditch and Edwin L. Drake, at a royalty of 5½ cents per gallon. This lease was superseded by another to the same parties, fixing the royalty at 12 cents per gallon. Under the terms of this lease the Seneca Oil Company was formed, March 23, 1858, which drilled the first well in search of petroleum or rock oil in the underlying rocks, finding it in quantity in August, 1859, at a depth of 69½ feet. The selection of this locality was most fortunate, as nowhere else on Oil creek was petroleum found in quantity at so shallow a depth.

In the year 1860 petroleum was found all along Oil creek to its mouth; also at Henrys Bend, Tidioute, and Franklin on the Allegheny river, and at Smiths Ferry on the Ohio river.

During the year 1861 there was an immense amount of prospecting done, wherever any signs of oil were found, from central New York to Alabama, and from the Manitoulin Islands, in northwestern Ontario, to eastern Kentucky. In Europe, also, arrangements for drilling wells were completed. In Russia, Roumania, Galicia, and India, where oil springs and shallow wells or pits had produced petroleum in limited quantities for many years previously, the idea of drilling wells in order to secure larger supplies from greater depths seems only to have been entertained after the wonderful results were accomplished on Oil creek, Pennsylvania.

The year 1861 was also remarkable for the large flowing wells that were found; several are credited with flowing from 2,000 to 2,500 barrels per day. This caused a remarkable fall in the price, which was as low, in some cases, as 10 cents per barrel, yet without purchasers. The means of storage and transportation, too, were utterly inadequate to handle such quantities. There was some oil secured from old salt wells on the Kanawha and Little Kanawha rivers during this year.

The refiners of cannel coal and cannel slate along the Allegheny river, near Freeport, and elsewhere, soon turned their attention to the refining of crude petroleum and abandoned the distillation of cannel slate. This movement materially assisted in the distribution and consumption of the new illuminant.

The remarkable growth of the industry during these early years is shown by a comparison of the yearly outputs, which are estimated as follows:

	Barrels.
1859	2,000
1860	500,000
1861	2,113,609
1862	3,056,690
1863	2,611,309
1864	2,116,109

The year 1864 showed somewhat of a decline, while the facilities for transportation, as well as the demand for the manufactured products, were steadily increasing. The price advanced in June, 1864, to $12.12 per barrel and was fairly well maintained throughout the remaining portion of the year.

In the spring of 1865 there was a freshet which did great damage to oil properties along Oil creek, in some instances, in the more exposed locations, wiping them out of existence. The productive area was considerably enlarged during the year, as oil was obtained in quantity at Church Run, Pithole, Parkers Landing, and on Dunkard creek in Greene county, in southern Pennsylvania; at White Oak and Burning Springs, in West Virginia, and at Cow Run and other localities in southeastern Ohio.

There were also numerous test wells located in eastern Kentucky and central Tennessee. The success of the original investors incited others to thoroughly canvass the country wherever a spring carried a trace of petroleum, or where natural gas was found bubbling in the water, and wherever an abandoned salt well, which had given showings of petroleum, was located, a well was projected.

The first well drilled for petroleum within the borders of West Virginia was begun in 1859 and finished in May, 1860, by the Rathbon Brothers, of Parkersburg. It was located near Burning Springs run; it was drilled by a spring pole, to a depth of 303 feet, at which point the Dunkard or Cow Run sand was penetrated and it flowed 100 barrels per day. This well and tract were sold to a company organized at Parkersburg and a second well was drilled before the close of 1860, which at 300 feet flowed 30 to 40 barrels per hour. The opening of these two promising wells was followed by a great rush of prospectors and a village was soon erected.

At the height of the development in 1863 the Confederate cavalry forces raided the region and set fire to about 300,000 barrels of petroleum that had been stored in tanks, and completely frightened away the capitalists who had invested in the field. The wells were not reopened for several years, when they were found to be unproductive.

Transportation.—In the early history of petroleum production it became necessary to find some other means of transporting the crude oil to the railroads and the navigable streams than in barrels conveyed by wagons. The measure adopted was the pipe line system, the success of which gradually displaced, in a great measure, transportation by rail and boat, and developed a new and a remarkably cheap and efficient system of transportation for both the crude and refined product. Pipe lines have proved indispensable to the general industry of petroleum and natural gas. The fact that the manufacturer could supply at a reasonable price wrought iron pipe in sizes up to eight inches in diameter which would stand 1,000 to 1,500 pounds pressure to the square inch, and had almost perfect joints, has aided greatly the economical collection and distribution of petroleum in all the producing regions.

The first petroleum from Oil creek was shipped in barrels made of oak staves banded with hoop iron. The penetrating and salient nature of crude petroleum made it difficult to manufacture barrels that would retain it, even after these barrels had been coated inside with hot glue. The difficulty of returning the barrels when empty, the uncertainty of their condition, and the liability to loss by this method of transportation, made it very unsatisfactory, and a source of annoyance to shippers and transportation companies.

About the year 1865 railroads put wooden tanks or tubs for carrying crude petroleum in each end of box cars, a car thus equipped holding from 2,000 to 4,000 gallons. While this improvement was being made by the railroads, transportation by the Allegheny river was also greatly improved by the use of bulk oil boats. These boats, each of which held from 1,500 to 2,000 barrels, were made 130 feet long, 22 feet broad, from 3½ to 4½ feet in depth and were divided into 8 watertight compartments. These were loaded at Oil City and floated down the river to the refineries at Freeport, Pittsburg, Rochester, Mingo, Wheeling, Marietta, and Parkersburg. The latter points also received crude petroleum transported in bulk boats from Burning Springs on the Little Kanawha river. When there was water enough in the Allegheny river these empty bulk boats and flats were towed upstream by steam towboats; at times of low water they were towed up by horses.

Though these improvements in transportation, both by rail and by boat, removed a part of the difficulty, there yet remained the obstacles that were experienced in moving the crude petroleum from the wells to the railroad or river. This was still done by team, and the roads were often almost impassable on account of the depth of the mud: the method was at best expensive, and accompanied by great hardship to man and beast. It was chiefly this condition which restricted the amount of petroleum that could be put upon the market.

This condition of affairs suggested the first pipe line. The first one that was a success was constructed by Mr. Daniel Van Syckle, of Titusville, Pa., in the summer of 1865, extending from Pithole to the railroad at the Miller farm, on Oil creek, a distance of 4 miles. In the fall of the same year, Henry Harley constructed a pipe line from Benninghoff run to the Shaffer farm. The original line built by Van Syckle was purchased by the firm of Abbot & Harley, who united the two under the name of the Allegheny Transportation Company. Both of these lines were successful, much to the discomfiture of the teamsters and roustabouts, who, in some instances, interfered with the operation of the line by cutting or pulling it in two with their teams. A number of arrests followed, and from then on the pipe line was an accomplished fact and an important factor in the collection and delivery of petroleum to points where it could be loaded in tank cars or bulk boats. The growth of long pipe lines was gradual, and it was several years before it was practically demonstrated that long lines could be successfully operated. The improvement in railway transportation by the introduction of the iron tank car was a decided advance over the wooden tanks set in box and flat cars, which for a time answered all the requirements.

The tanks at the wells are connected by a system of small lines or veins which feed the main lines or arteries. These smaller lines usually are concentrated at the lowest portions of the field drained at points known as local pumping stations. A considerable proportion of the oil finds its way into the tanks at these stations by gravity and is forced to the large receiving tanks at the main station by pumps, which are often driven by natural gas engines, or it flows by gravity through suction lines to pumps into pits and is then elevated to receiving tanks. From the large receiving tanks the petroleum is forced into the main lines at a pressure often of between 600 and 900 pounds to the square inch.

These massive pumps generally represent the highest known mechanical efficiency, having triple expansion engines, Corliss valves, condensers, air pumps, and efficient boilers. They usually develop 300 to 400 horsepower and handle from 30,000 to 35,000 barrels in twenty-four hours. The boilers are economical and properly proportioned to this work, showing a duty of 16 pounds of water evaporated at and above 212 F. per pound of crude petroleum consumed as fuel. One pound of good coal will evaporate 10 pounds of water, and 1 pound of natural gas (equal to 20 cubic feet) will evaporate 20 pounds of water under the same conditions.

The main pumping plants are placed from 30 to 50 miles apart, according to the elevation of summits that must be overcome; and by the addition of a parallel line, or loop lines, for a portion of the way the distance can be increased so as to reach localities convenient for fuel or water without greater tax upon the pumps.

There are probably 4,600 miles of main trunk line, from 4 to 8 inches in diameter, in the Appalachian and the Lima-Indiana fields, reaching from northern Tennessee to Parkersburg, Cleveland, Buffalo, Franklin, Olean, and to the seaport cities of New York, Philadelphia, and Baltimore. From the Lima-Indiana field the main lines reach westward to Chicago, Montpelier, Toledo, Lima, and eastward it connects with the Appalachian system.

Kansas has an extensive system of main lines and local lines, reaching in several directions from Neodesha. In California a main line was recently completed, reaching from Bakersfield to a refinery at Point Richmond, near San Francisco, and having a branch line to Coalinga. The length of this main line is 278 miles, and it is connected near its starting point with about 150 tanks holding 35,000 barrels each. There are other smaller lines in California, extending from Pico canyon to Ventura and connecting Fullerton with Los Angeles.

Texas has in the last two years greatly increased its mileage of main line. There are four lines from 22 to 30 miles in length, reaching from the original field near Beaumont to tide water on the Gulf, and connecting it with Port Arthur and Sabine Pass. Sour Lake and Saratoga are also connected by pipe lines with Beaumont. The Corsicana field in the northeastern part of the state is connected by pipe lines with the refinery there. The length of the entire system of main lines in use in the United States in 1902 was approximately 7,800 miles, a large portion of which is double and triple lines, to which may be added 50,000 miles of smaller lines connecting the 51,774 tanks of the producing wells with the iron tanks of the receiving and transporting companies.

As early as 1875 organizations were effected and charters secured for the privilege of building pipe lines to the seaboard. However, these chartered companies at that time confined their operations to the oil regions, where they built numerous lines, usually of a 2-inch diameter, to the several railroads and their branches and to the nearby refineries. The competition among these new pipe line companies for securing the production of the fields began to be marked, especially in Butler county, Pa., and rates for delivery were cut to such an extent that the lines were in several instances operated at a loss. The demand for a consolidation of these competitive companies became more and more emphatic. Under the title of the Fairview Pipe Line a company was organized by Capt. J. J. Vandergrift and George V. Foreman, under the laws of Pennsylvania, the act bearing date of April, 1874. This company was afterwards known as the United Pipe Line Association. Into it was merged, from time to time, the other local lines until it controlled almost the entire system. Gradually the temporary and uncertain characteristics of pipe line transportation disappeared, and more permanent structures were built.

The first trunk line, constructed in 1875, was 39 miles long and built of 4-inch pipe, now removed. It started at Carbon Center, 5 miles east of the town of Butler, Butler county, Pa., and extended to Brilliant, a suburb of Pittsburg. The trunk line to Cleveland, Ohio, was completed in the summer of 1879. This was a 5-inch line, beginning at Hilliard station, in the northern portion of Butler county, 8 miles west of Bear Creek station, and extending 103 miles to Cleveland, Ohio, where it supplied the refineries that had formerly received their crude petroleum by tank cars. There were relay stations on this line at intervals of 25 to 30 miles.

During the same year other shorter lines were laid in the Bradford field, reaching the Erie Railroad at Carrollton and Olean on the north and the Pennsylvania Railroad at Kane on the south. In the winter of 1879 and 1880 the first trunk lines to the seaboard were begun. The one in Pennsylvania, which was built of 6-inch pipe, started at Colegrove, in McKean county, and extended to Philadelphia, a distance of 235 miles; a 5-inch branch line left the main line at Millway and extended 66 miles to Baltimore, Md. The other seaboard lines started at Olean, N. Y., and were laid double; there were two 6-inch lines, running parallel through the southern counties of New York to Saddle River, N. J., where they separated, one terminating at the Bayonne refineries in New Jersey, the other passing on, under the North and East rivers, to the refineries located at Hunters Point, on Long Island. The distance between the points named was about 313 miles; the length of the pipe required by reason of loops, etc., was 762 miles. Olean was shortly afterwards connected by pipe line with Bear Creek station, on the Allegheny river, near Parker, Pa., making a continuous line to Bayonne, N. J., a distance of 420 miles.

The southern trunk line, which begins at Morgantown, W. Va., extends across nearly the whole length of the state to Philadelphia, a distance of 274 miles; it was completed in 1890.

The cheap and efficient method of transportation by trunk pipe lines, permitting the crude and refined petroleum to be delivered at seaboard at a cost much less than it was possible for it to be transported by rail or canal, marked an important era in the history of the petroleum industry. Many problems had to be solved in the construction of the first pipe line. The question of the proper selection of pipes and the making of pipe joints that would not leak under the great pressure; the manner of carrying pipe lines across large streams and rivers and over high, steep hills; the selection of proper localities for tanks and pump stations; the selection of pumps; the cleaning of the pipes when foul; and the method of equalizing distance between pump stations, by the doubling of a portion of the line, so as to equalize the work on the pumps at each station, were all new conditions and demanded the highest mechanical and engineering skill in order to overcome them. These difficulties were all surmounted in a comparatively short time.

The transportation annually of 10,000,000 tons of petroleum an average distance of 380 miles by pipe lines, with only insignificant loss by leakage, evaporation, or fire, represents a triumph of the highest engineering and mechanical skill. The introduction of the pipe line system brought about the removal of the refining branch of the petroleum industry to the centers of manufacture in the lake and seaboard cities, where at least 80 per cent of the crude product is now converted into illuminating oils and other merchantable commodities. Great numbers of the small refineries, that were formerly scattered over western New York, western Pennsylvania, West Virginia, and southeastern Ohio, have disappeared, and the business of refining oil has been transferred to the immense refining plants near New York, Philadelphia, Baltimore, Cleveland, Buffalo, and Whiting, Ind.; Port Arthur, Tex.; and Point Richmond, Cal. From these great industrial centers the manufactured petroleum finds its way to the markets of the world by ocean tank steamers, or by the bulk carriers of our inland lakes, or it is distributed by rail in tank cars to the consumers who can not be reached by these more economical methods of transportation. The important inland refineries remaining are located at Olean, N. Y.; Titusville, Oil City, Franklin, Warren, and Pittsburg, Pa.; Parkersburg, W. Va.; Lima, Ohio; Neodesha, Kans.; Corsicana, Tex., and Florence, Colorado.

The pipe line companies for many years have been the purchasers of the crude petroleum in the older fields. The pipe line company, upon application from the producer, sends an agent, generally known as a gauger, to measure and inspect the petroleum in his tank and run it into its lines. The tanks throughout the field are carefully measured and numbered, and when the oil is accepted and run into the tanks of the pipe line company a card is issued showing the number of barrels to the credit of the producer. Every tank is carefully gauged and numbered and a table prepared, which shows the number of barrels it contains for every inch of liquid from top to bottom. The temperature of the crude petroleum is also recorded and the contents of the tank examined for water. After measuring the petroleum the gauger gives the operator what is known as a "run ticket," keeping a copy for himself. The pipe line company deducts the royalty due the owner of the property according to the terms of an agreement on file at the office, and the next day the producer may secure the cash for his petroleum at the market quotation for the day or hour of his sale at the nearest home office of the company.

If the producer wishes, he can secure a certificate when his production in the tanks of the pipe line company amounts to 1,000 barrels. These pipe line certificates are made payable to bearer and are therefore transferable. They are subject to transportation charge in the district of 20 cents per barrel, and to a charge for storage at the rate of 25 cents per day per 1,000 barrels when the price is less than $1; 30 cents when over $1 and under $1.50; and 40 cents for all over $1.50 per barrel. They are to be returned for exchange to the pipe line company within six months after issue, being subject to a charge of one-twentieth of 1 per cent daily thereafter until exchanged. To cover losses by fire or lightning, certificates are subject to an assessment pro rata on all oil in custody of the pipe line. None of these charges are included in the prices as quoted and which are the prices at or near the wells. To these prices, when the oil is delivered to the refineries, charges are added for storage and transportation.

It was upon these certificates that the speculative business at the exchanges at New York, Bradford, Titusville, Oil City, and Pittsburg was based.

TABLE 46.—DETAILED SUMMARY: 1902.

	United States.	California.	Colorado.	Indiana.	Kansas.	Kentucky.	New York.	Ohio.	Pennsylvania.	Texas.	West Virginia.	All other states and territories.[1]
Number of wells	118,671	2,757	111	9,439	470	392	8,443	42,483	40,444	955	13,109	68
Number of operators	29,522	290	12	2,567	12	39	2,123	10,002	9,808	211	4,446	12
Character of ownership:												
Individual	29,031	68	3	2,561	3	1	2,122	10,001	9,806	26	4,440	
Firm	69	31		2		2				30	4	
Incorporated company	417	190	9	4	9	36	1	1	1	152	2	12
Other form	5	1							1	3		
Salaried officials, clerks, etc.:												
Total number	3,053	384	23	108	33	63	69	450	570	999	328	26
Total salaries	$2,986,768	$452,520	$43,055	$138,536	$31,664	$44,376	$92,116	$629,369	$686,098	$444,129	$399,207	$25,778
General officers—												
Number	439	117	8	3	11	5	5	22	23	228	11	6
Salaries	$650,933	$148,011	$24,655	$17,747	$9,745	$4,810	$23,031	$131,696	$109,082	$111,649	$61,007	$9,500
Superintendents, managers, foremen, surveyors, etc.—												
Number	1,834	164	8	78	14	37	51	333	359	545	234	11
Salaries	$1,709,417	$223,122	$10,960	$95,560	$16,960	$33,376	$55,083	$397,769	$369,868	$242,174	$253,245	$11,300
Clerks—												
Number	780	103	7	27	8	21	13	95	188	226	83	9
Salaries	$626,498	$81,387	$7,440	$25,229	$4,959	$6,190	$14,002	$99,904	$207,148	$90,306	$84,955	$4,978
Wage-earners:												
Aggregate average number	17,552	1,112	147	1,463	146	79	408	4,017	5,610	723	3,800	47
Aggregate wages	$13,242,351	$1,087,839	$138,436	$1,045,925	$108,756	$69,189	$296,713	$2,915,787	$4,072,287	$799,209	$2,773,312	$34,908
Engineers, firemen, and other mechanics—												
Average number	16,773	834	100	1,462	111	66	408	3,968	5,594	482	3,713	35
Wages	$12,654,686	$859,102	$109,700	$1,045,225	$90,617	$61,678	$296,713	$2,881,687	$4,062,271	$601,251	$2,718,174	$28,278
All other wage earners—												
Average number	779	278	47	1	35	13		49	16	241	87	12
Wages	$587,665	$228,737	$28,736	$700	$18,139	$7,511		$34,100	$10,016	$197,958	$55,138	$6,630
Average number of wage earners at specified daily rates of pay:												
Engineers—												
Less than $0.50	1					1						
$0.50 to $0.74	1	1										
$0.75 to $0.99	2	1										1
$1.00 to $1.24	57	7	1	17		5	1	15	10		1	
$1.25 to $1.49	51	1		5		5		26	8	4	2	
$1.50 to $1.74	63	2		10	11			29		7	2	2
$1.75 to $1.99	401	7		21	28	2	13	169	146	14	1	
$2.00 to $2.24	601	87		184	7	2	12	158	142	5	1	3
$2.25 to $2.49	9,872	33	17	1,164		5	289	3,237	3,209	6	1,912	
$2.50 to $2.74	1,580	172	3		6	3	24		776	30	563	3
$2.75 to $2.99	72	22	34	1	1					14		
$3.00 to $3.24	182	58				2				122		
$3.25 to $3.49	16	5								11		
$3.50 to $3.74	25	1				1				23		
$3.75 to $3.99	1			1								
$4.00 to $4.24	7	1	2							4		
$4.25 and over	16	7				1				8		
Firemen—												
$1.50 to $1.74	1					1						
$2.00 to $2.24	5			2	1					1		1
$2.50 to $2.74	20	9				1				10		
$2.75 to $2.99	8	4								4		
$3.00 to $3.24	24	7								17		
$3.25 to $3.49	3									3		
$3.75 to $3.99	1	1										
$4.25 and over	3				1					2		
Machinists, blacksmiths, carpenters, and other mechanics—												
$1.00 to $1.24	12	1			2	1					5	3
$1.25 to $1.49	4				1	2						1
$1.50 to $1.74	549	4			1	3	9		292	3	237	
$1.75 to $1.99	633	3		3	7	1	10		337		265	7
$2.00 to $2.24	572	26		15	5	5	31	22	241	16	209	2
$2.25 to $2.49	138	15		10	4	5		73	8		22	1
$2.50 to $2.74	502	50	8	5	3	1	7	107	48	92	175	6
$2.75 to $2.99	147	3	3	3	2		2		55	8	70	1
$3.00 to $3.24	570	114	3	12	12	4	6	66	180	41	132	
$3.25 to $3.49	258	7	2		3		4		133	10	99	
$3.50 to $3.74	57	20	18		3				8	3	5	
$3.75 to $3.99	34	22		2		3					7	
$4.00 to $4.24	16	10	1		2					3		
$4.25 and over	265	133	8	7	11	12		66	1	18	5	4

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[1] Includes operators and wells distributed as follows: Illinois, 1 (2 wells); Indian Territory, 2 (13 wells); Louisiana, 2 (17 wells); Michigan, 1 (13 wells); Missouri, 2 (10 wells); Oklahoma, 1 (5 wells); Tennessee, 1 (7 wells); Wyoming, 2 (3 wells).

TABLE 46.—DETAILED SUMMARY: 1902—Continued.

	United States.	California.	Colorado.	Indiana.	Kansas.	Kentucky.	New York.	Ohio.	Pennsylvania.	Texas.	West Virginia.	All other states and territories.
Average number of wage-earners at specified daily rates of pay—Continued.												
All other wage-earners—												
$0.75 to $0.99	2	1								1		
$1.00 to $1.24	5	1	1			1				2		
$1.25 to $1.49	6	3			1	2						
$1.50 to $1.74	86	2	30		18	4		4		1	18	9
$1.75 to $1.99	41	6	1					4		20	10	
$2.00 to $2.24	225	78		1	15	4		41	16	22	18	
$2.25 to $2.49	36	15	1			1				16	3	
$2.50 to $2.74	264	116	8		1					133	6	
$2.75 to $2.99	15	4	3							4	2	2
$3.00 to $3.24	83	40	2							40		1
$3.50 to $3.74	7	5	1							1		
$3.75 to $3.99	2	2										
$4.00 to $4.24	2					1				1		
$4.25 and over	5	5										
Average number of wage-earners employed during each month:												
Men 16 years and over—												
January	17,364	1,094	163	1,381	135	49	410	4,067	5,585	605	3,851	36
February	17,238	1,060	170	1,364	138	49	408	3,973	5,620	606	3,814	36
March	17,346	1,117	151	1,388	136	54	408	3,976	5,620	651	3,809	36
April	17,435	1,105	152	1,423	137	74	409	4,006	5,621	661	3,811	36
May	17,482	1,093	140	1,431	140	74	410	4,009	5,622	698	3,826	39
June	17,364	1,073	157	1,443	143	74	408	4,018	5,585	615	3,799	49
July	17,484	1,098	116	1,464	149	82	407	4,020	5,583	700	3,769	96
August	17,517	1,085	142	1,493	150	87	407	4,029	5,580	735	3,753	56
September	17,566	1,086	146	1,517	149	96	406	4,035	5,566	782	3,729	54
October	17,863	1,138	139	1,541	150	112	407	4,046	5,614	863	3,799	54
November	17,934	1,185	118	1,542	161	105	408	4,046	5,633	875	3,811	52
December	18,001	1,212	137	1,569	164	92	408	4,012	5,643	885	3,829	50
Contract work:												
Amount paid	$12,856,681	$431,029	$9,650	$1,091,333	$90,467	$104,162	$272,779	$2,212,923	$2,969,046	$1,363,463	$4,176,647	$135,182
Number of employees	7,949	352	28	1,310	105	171	183	1,802	1,391	1,061	1,106	17
Miscellaneous expenses:												
Total	$15,811,726	$571,138	$40,163	$1,286,499	$51,054	$147,295	$259,740	$4,896,861	$3,275,131	$713,176	$4,523,499	$47,170
Royalties and rent of wells and plants	$8,929,891	$214,261	$18,597	$1,034,070	$28,255	$53,613	$194,717	$3,046,994	$1,916,987	$261,150	$2,132,243	$29,004
Rent of offices, taxes, insurance, interest, and other sundries	$6,881,835	$356,877	$21,566	$252,429	$22,799	$93,682	$65,023	$1,849,867	$1,358,144	$452,026	$2,391,256	$18,166
Cost of supplies and materials	$17,781,512	$1,479,528	$68,708	$1,126,627	$296,821	$227,822	$140,004	$5,504,792	$3,356,666	$635,937	$4,564,908	$39,750
Product:												
Quantity, barrels of 42 gallons	89,275,302	13,984,268	396,901	7,480,896	331,749	[1] 248,950	1,119,730	21,014,231	12,063,880	18,515,017	13,513,345	606,335
Value	$71,397,739	$4,873,617	$484,683	$6,526,622	$282,464	$172,857	$1,590,852	$20,757,359	$15,266,093	$4,174,731	$17,040,317	$278,164
Power:												
Total horsepower	910,077	17,876	1,279	23,018	1,244	1,954	39,262	135,472	497,192	8,707	183,524	449
Owned—												
Engines—												
Steam—												
Number	41,797	786	73	556	55	55	2,517	6,262	22,084	240	9,126	33
Horsepower	666,177	14,367	1,202	8,418	699	1,689	34,547	81,317	333,158	6,121	182,543	407
Gas or gasoline—												
Number	12,609	112	4	812	21	17	251	3,187	8,107	29	65	4
Horsepower	240,595	2,274	77	14,600	530	196	5,015	54,247	162,137	500	981	42
Other power—												
Number	37	3			1					33		
Horsepower	1,172	132			15					1,025		
Rented—												
Electric, horsepower	125	125										
Other power, horsepower	2,068	376				60				1,632		
Electric motors, owned—												
Number	2	2										
Horsepower	25	25										
Supplied to other establishments, horsepower	612	356								256		

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[1] Includes 1,520 barrels, valued at $1,370, obtained as a by-product of natural gas wells.

NATURAL GAS

NATURAL GAS.

By F. H. Oliphant.

The existence of natural gas, in greater or less quantity, accompanying petroleum, has been known since the early development of that industry, beginning with 1859. The introduction of this gas, first as a fuel and light, afterwards as a source of power, was slow. The doubt concerning the duration of the supply, the lack of appreciation of its value as a fuel, and the uncertainty as to transportation contributed largely to postpone its general use. The subsequent demonstration that it existed in large quantities in natural reservoirs, that it could be conveyed efficiently in pipe lines, and that it was of great utility as a fuel caused a remarkable increase in its consumption, and natural gas soon became one of the most valuable of mineral productions. Although used extensively as far back as 1882, it was not regarded as of sufficient commercial value to warrant statistical consideration until during the decade ending with 1890. The reports of the Eleventh Census are the first in which this industry is presented. The statistics for 1902 and 1889 are summarized in the following table:

TABLE 1.—*Comparative summary: 1902 and 1889.*

	1902	1889
Number of wells	15,806	[1]2,247
Number of operators	1,967	(2)
Salaried officials, clerks, etc.:		
Number	1,920	785
Salaries	$1,810,357	$525,986
Wage-earners:		
Average number	4,678	5,899
Total wages	$2,998,579	$1,210,433
Contract work	$1,150,001	(3)
Miscellaneous expenses	$5,912,257	(3)
Cost of supplies and materials	$6,447,246	[4]$13,184,467
Value of product	$30,867,863	[5]$21,097,099

[1] Producing wells only.

[2] Not reported.

[3] Not reported separately.

[4] Includes the amounts expended for contract work, and for labor and materials used in development work.

[5] Value of fuel displaced; amount actually received by producers was $11,044,858.

The number of wells producing at the close of December, 1889, was given as 2,247, and the amount received for the gas consumed was $11,044,858. The value of the fuel displaced was computed at $21,097,099, including that displaced by gas used at oil pipe line stations, in pumping and drilling oil wells, and for other purposes. This was regarded as the actual value. The value given for 1902 is the amount received from the sale of the gas. The quantity and value of petroleum produced from natural gas wells are included in the statistics for petroleum, but the statistics pertaining to wages, employees, and other expenses are included under natural gas.

During 1902, 15,806 wells were operated; of this number, 1,250 were abandoned during the year, leaving 14,556 that were productive at the close of the year. These 14,556 wells produced natural gas valued on an average at $2,147 for each well. During the year 1889 the output of the 2,247 wells producing natural gas was valued at $4,915 per well. As a result of the severe competition in the marketing of natural gas during 1889 and the large outlay caused by the drilling of numerous wells and the construction of a number of pipe lines, the expenses were $3,876,028 greater than the amount received from the sale of the natural gas produced in that year. The quantity of natural gas marketed during 1902 is estimated to have been 205,784,453,333 cubic feet, which was sold at an average price of 15 cents per 1,000 cubic feet. The quantity marketed in 1889 is estimated to have been 552,150,000,000 cubic feet, which gives an average of 2 cents per 1,000 cubic feet. At that time a very large proportion was used for fuel purposes in mills and factories; afterwards it came to be used very generally as a domestic fuel.

A large amount was wasted and unnecessarily consumed in the years closely following the introduction of natural gas, but this waste has in a great measure been overcome in the more economical combustion of the gas, and better prices have been obtained.

The value of coal that was displaced in 1902 by natural gas is estimated to have been $39,798,833, as compared with $21,097,099 in 1889; or it may be said that while the quantity of natural gas produced in 1902 was 168.3 per cent less than that produced and sold in 1889 the revenue from it was 179.5 per cent more.

The following table shows the value of the natural gas produced in 1902, the record of wells, and the length of pipe in use up to the close of 1902, by states:

TABLE 2.—VALUE OF NATURAL GAS PRODUCED, RECORD OF WELLS, AND LENGTH OF PIPE LAID, BY STATES: 1902.

STATE	Value of natural gas produced during 1902	WELLS				TOTAL LENGTH OF PIPE LAID UP TO DECEMBER 31, 1902	
		Operated during 1902	Abandoned during 1902.	Producing during 1902	Dry or nonproducing during 1902	Feet.	Miles.
Total	$30,867,863	15,806	1,250	[1]14,556	721	131,859,690	24,973.41
California	120,648	29		29		365,925	69.30
Illinois	1,844	28		28	2	31,891	6.04
Indiana	7,081,344	6,861	882	5,979	265	36,121,980	6,841.28
Kansas	824,431	114	21	80	63	5,034,791	953.56
Kentucky	365,611	117		117	2	749,875	142.02
Missouri	2,154	13		13	2	14,672	2.78
New York	346,471	612	14	598	8	5,894,517	1,116.38
Ohio	2,355,458	1,392	75	1,277	46	20,093,670	3,805.62
Pennsylvania	11,352,183	5,468	203	5,206	232	48,863,621	9,254.48
South Dakota	10,280	6	1	5	1	26,900	5.09
Texas	14,965	14		14		96,196	18.22
West Virginia	5,390,181	949	51	898	37	14,548,395	2,755.38
All other states and territories[2]	2,305	3		1	2	17,200	3.26

[1] Includes 51 wells that were not used.

[2] Includes Colorado, Indian Territory, and Tennessee.

Capital stock of incorporated companies.—Of the 651 incorporated companies, 430 reported capitalization. The details of their capitalization are shown in the following table:

TABLE 3.—CAPITALIZATION OF INCORPORATED COMPANIES, 1902.

	United States	California	Indiana.	Kansas	Kentucky.	New York	Ohio	Pennsylvania	West Virginia	All other states.[1]
Number of incorporated companies	651	6	337	37	6	29	59	126	46	5
Number reporting capitalization	430	1	229	19	5	21	32	86	33	1
Capital stock and bonds issued	$111,634,737	$1,044,000	$39,669,670	$3,737,262	$4,147,000	$2,361,400	$17,657,400	$28,610,475	$14,094,530	$15,000
Capital stock:										
Total authorized—										
Number of shares	6,526,072	15,100	1,650,047	3,528,923	37,120	32,694	311,855	613,269	336,444	300
Par value	$99,400,806	$790,000	$28,002,593	$4,318,250	$3,715,000	$2,287,200	$17,093,900	$27,246,403	$15,944,100	$5,000
Total issued										
Number of shares	5,185,230	14,640	1,618,911	2,400,935	33,260	32,304	295,939	598,973	189,806	300
Par value	$92,190,870	$744,000	$26,679,003	$3,190,262	$3,309,000	$2,254,400	$16,344,400	$26,234,275	$13,132,530	$5,000
Dividends paid	$4,944,034	$2,880	$739,602	$7,500	$49,000	$61,325	$649,157	$2,876,094	$578,496	
Common—										
Authorized—										
Number of shares.	6,512,802	15,100	1,646,047	3,527,923	37,120	32,694	311,855	605,269	336,194	300
Par value	$98,565,806	$790,000	$27,602,593	$4,308,250	$3,715,000	$2,287,200	$17,093,900	$26,846,403	$15,919,100	$5,000
Issued										
Number of shares.	5,172,580	14,640	1,614,911	2,399,935	33,260	32,304	295,939	591,573	189,556	300
Par value	$91,385,870	$744,000	$26,279,003	$3,180,262	$3,309,000	$2,254,400	$16,344,400	$25,864,275	$13,107,530	$5,000
Dividends paid	$4,894,134	$2,880	$715,602	$7,500	$49,000	$61,325	$649,157	$2,850,194	$578,496	....
Preferred—										
Authorized—										
Number of shares.	13,270	......	4,000	1,000	......	......	......	8,000	270	......
Par value	$835,000	....	$400,000	$10,000	......	......	......	$400,000	$25,000	....
Issued—										
Number of shares.	12,650	......	4,000	1,000	......	......	......	7,400	250	....
Par value	$805,000	..	$400,000	$10,000	......	......	......	$370,000	$25,000	......
Dividends paid	$49,900	.....	$24,000	......	......	......	......	$25,900	.....	......
Bonds:										
Authorized—										
Number	50,938	300	31,571	925	8,880	100	3,980	3,170	1,612	1,000
Par value	$20,642,867	$300,000	$13,520,667	$547,000	$848,000	$110,000	$1,428,000	$2,577,200	$1,312,000	$10,000
Issued—										
Number	48,659	300	30,501	925	8,380	97	3,415	2,969	1,172	1,000
Par value	$19,443,867	$300,000	$12,990,667	$547,000	$838,000	$107,000	$1,313,000	$2,376,200	$962,000	$10,000
Interest paid	$1,041,402	$18,000	$697,100	$35,820	$50,280	$6,170	$77,400	$133,112	$43,520	....
Assessments levied	$1,121,776	$113,000	$127,883	$20,260	......	......	$80,000	$780,633	....	....

[1] Includes companies distributed as follows: Colorado, 3; Missouri, 1; Tennessee, 1. Of these the company in Missouri did not report details of capitalization. The details of capitalization for the 3 companies in Colorado are included in the report on petroleum.

The capital stock and bonds issued amounted to $111,634,737. The number of shares of capital stock issued was 5,185,230, and the total par value was $92,190,870. The average value of the shares was $17.78. The dividends paid amounted to $4,944,034, or 5.4 per cent of the total par value of shares issued. The dividends paid in Pennsylvania amounted to 10.9 per cent on the stock issued, which was the largest rate returned; on the other hand, the dividends paid in Kansas amounted to only two-tenths of 1 per cent. There were 48,659 bonds issued having a par value of $19,443,867; the interest paid reached $1,041,402 and the assessments levied amounted to $1,121,776.

Employees and wages.—Wage-earners constituted 70.9 per cent of the total number of employees, and their wages were 61.9 per cent of the total salaries and wages. Table 4 shows the average number of wage-earners employed during each month.

TABLE 4.—*Average number of wage-earners employed during each month: 1902.*

January	3,821
February	3,577
March	3,623
April	3,948
May	4,113
June	4,577
July	4,632
August	5,084
September	5,670
October	5,498
November	5,392
December	6,337

The minimum average number of wage-earners employed was 3,577, during the month of February, and the maximum, 6,337, during December. The increase was great during the summer months, but was greatest toward the close of the year, when a number of large natural gas mains were constructed in West Virginia, Ohio, and Pennsylvania.

Of the total number of wage-earners employed in the United States during 1902 by natural gas companies, 94 per cent found employment in Pennsylvania, Indiana, Ohio, and West Virginia.

In the following table the number of wage-earners at each specified rate of pay is shown for the various classes of employees:

TABLE 5.—*Average number of wage-earners at specified daily rates of pay: 1902.*

RATE PER DAY (DOLLARS).	All occupations.	Engineers.	Firemen.	Machinists, blacksmiths, carpenters, and other mechanics.	Boys under 16 years.	All other wage-earners.
Total	4,678	352	121	1,074	2	3,129
0.50 to 0.74	2			1		1
0.75 to 0.99	11	1	......	2	1	7
1.00 to 1.24	28	5	....	2	1	20
1.25 to 1.49	248	4	14	8	..	222
1.50 to 1.74	1,230	51	30	51		1,098
1.75 to 1.99	873	39	30	118		686
2.00 to 2.24	1,090	80	21	429		560
2.25 to 2.49	558	38	19	195		306
2.50 to 2.74	326	57	4	121		144
2.75 to 2.99	72	14	......	37		21
3.00 to 3.24	67	22	...	35		10
3.25 to 3.49	8	3		5		.....
3.50 to 3.74	28	1	1	14		12
3.75 to 3.99	37	26		1		10
4.00 to 4.24	34	9	1	18	....	6
4.25 and over	66	2	1	37	....	26

Of the wage-earners 80.2 per cent received between $1.50 and $2.49 per day. The best paid wage-earners were those classified as machinists, blacksmiths, carpenters, and other mechanics. These are intrusted with manipulation of the wells, drips, and pipe lines in the field, and have charge of the lines and regulators in the cities and towns. Although the work is not often laborious, it requires good judgment and special training to deal successfully with the various conditions that require personal attention. The employees classified under the head of "all other wage-earners" include line walkers, regulator watchmen, men who relieve the wells and drips of salt water, men who carry out instructions as to the regulation of pressure on the main lines by opening or closing the gates at the wells, and men engaged in pulling out wells and retubing them as exigencies may require.

Contract work.—Besides these wage-earners an average of 3,268 workmen were employed as rig builders, drillers, and helpers, and were paid by contractors for drilling wells. This number, added to the 4,678 wage-earners in the regular employ of the natural gas companies, increases the number of wage-earners employed in the natural gas industry to 7,946. The workmen employed by the contractors in building rigs and in drilling wells are specialists and are usually men of more than ordinary ability and bodily strength. Their wages are high, ranging from $3 to $4.50 per day; their total earnings, however, are not great because of the time lost in moving from one location to another, which occurs frequently, as a well is completed usually in from twenty to forty days.

The contractors are generally paid by the foot. The price varies greatly because of the differences in the depth of the wells and the character of the strata passed through, and the number of different sizes of casing required to complete the well, which may vary from 1,000 to 2,500 feet in depth to the gas sand.

Where only a single string of 5⅝-inch casing is used, the price averages about forty-five cents per foot; where two strings of casing are required, the price per foot will average 75 cents. In the deep holes in southern Pennsylvania and West Virginia, where three and in some cases four strings of casing are required to complete a deep well, the price ranges from $1.20 to $1.50 per foot. The rig, or derrick, and the casing are generally furnished by the natural gas company, the contractor supplying everything else that is necessary to complete the well, and receiving pay only in case the well is turned over to the gas company in perfect condition. The plugging or loss of a well before it is completed falls upon the contractor.

Supplies, materials, and miscellaneous expenses.—The miscellaneous expenses, which amounted to $5,912,257, were made up of rents, royalties, taxes, insurance, and sundry expenses. The cost of supplies and materials amounted to $6,607,255, and included the cost of pipe, casing, tubing, engines, boilers, pumps, drips, regulators, and sundry other items necessary for the delivery of the natural gas to the points of consumption.

Mechanical power.—The total primary power employed in 1902 aggregated 104,107 horsepower. This was used to free the gas wells of water and to compress the gas so that it could be transported in sufficient quantity to the place where the original pressure had decreased. Of this horsepower 94,595, or 90.9 per cent, was generated by steam; 7,083, or 6.8 per cent, was supplied by gas or gasoline engines; and 2,162, or 2.1 per cent, was furnished by other prime motors. The rented horsepower was two-tenths of 1 per cent of the total, the amount being 267 horsepower; of this, 225 horsepower, or 84.3 per cent. was electric. In addition 6 electric motors, having a total capacity of 50 horsepower, were owned.

Production. It is estimated that the United States produced over 98 per cent of the world's output of natural gas in 1902. Canada produced 1.2 per cent, and the rest of the world the remaining eight-tenths of 1 per cent. The total value of the production of natural gas in the United States for 1902 was $30,867,863. This is the largest value thus far recorded in the history of the industry, and is equal to 43.2 per cent of the value of the petroleum produced in the same year. The following table, compiled from the published reports of the United States Geological Survey, shows the production of natural gas from 1872 to 1902:

TABLE 6.—*Value of production of natural gas: 1872 to 1902.*

YEAR.	Value.	YEAR.	Value.
Total	$317,757,731	1893	$14,346,250
1872 to 1884	[1] 9,100,000	1894	13,954,400
1885	[1] 4,857,200	1895	13,006,650
1886	[2] 10,012,000	1896	13,002,512
1887	[2] 15,817,500	1897	13,826,422
1888	[2] 22,629,875	1898	15,296,813
1889	[2] 21,107,099	1899	20,074,873
1890	[2] 18,792,725	1900	23,698,674
1891	15,500,084	1901	27,066,077
1892	14,800,714	1902	30,867,863

[1] Estimated.

[2] Value of coal and wood displaced.

If it be assumed that an average of 7 cents per 1,000 cubic feet was the price of natural gas from the time it was first introduced in 1872 until the close of 1902, the total value of the product for those years—$317,757,731—would indicate a volume of 4,539,396,159,000 cubic feet. If it were possible to confine this immense quantity of natural gas in a tank whose section was 1 square mile, and if the density would remain the same throughout, it would require a tank 30.8 miles long; or it would fill a pipe having a diameter of 67½ feet encircling the globe. This quantity represents a fuel value equal to 226,969,800 short tons of coal.

Large as this quantity of natural gas may seem, it probably does not represent more than one-half of the amount that has been taken from the original reservoirs. The early and even more recent development was accompanied by profligate waste, and large quantities were also lost during the development of the numerous petroleum fields, as many of the rocks above the petroleum strata, when pierced by the drill, were found to contain great quantities of natural gas, which was allowed to flow into the air until it was exhausted. In the early development of some of the largest fields many of the first wells, when the pressure was greatest, were permitted to discharge immense quantities into the atmosphere for months and years. Torches and escape pipes were allowed to consume and blow off great quantities. There seemed to be a general impression that these great reservoirs of natural gas were practically inexhaustible. The methods employed in applying the gas in mills and factories, and also in domestic service, were wasteful in the extreme. For many years the natural gas companies allowed their customers to consume any quantity that would pass through a certain sized orifice. The mills and factories usually paid according to the amount of finished product, using the gas as they saw fit, which was often in the most crude and extravagant manner.

In a measure this condition was brought about by a number of companies owning wells in the same field over which the declining pressure adjusted itself. When the pressure began to decline each owner made an attempt to realize the greatest revenue before the field became exhausted to such an extent that his pipes could not deliver sufficient natural gas to cause the returns to be profitable.

It has been estimated that since the beginning of the industry the greatest quantity of natural gas was consumed in 1888. This quantity, estimated to have been not less than 750,000,000,000 cubic feet, was partly utilized and partly wasted. It is estimated that it displaced fuel to the value of $22,629,875, which gives an average of 3 cents per 1,000 cubic feet.

Because of the nature, occurrence, and uses of natural gas, it is a very difficult task to ascertain the exact value and quantity consumed; every effort, however, has been made to secure these totals, and each succeeding year the records have been nearer the true amount, and the quantity unreported has gradually become less.

The following table gives the value of the natural gas produced and the value of that consumed in the United States from 1899 to 1902, by states:

TABLE 7.—VALUE OF NATURAL GAS PRODUCED AND CONSUMED, BY STATES: 1899 TO 1902.

STATE.	1902		[1] 1901		[1] 1900		[1] 1899	
	Produced.	Consumed.	Produced.	Consumed.	Produced.	Consumed.	Produced.	Consumed.
United States	$30,867,863	$30,867,863	$27,066,077	$27,066,077	$23,698,674	$23,698,674	$20,074,873	$20,074,873
Pennsylvania	14,352,183	13,942,823	12,688,161	11,785,996	10,215,412	9,812,615	8,337,210	7,926,970
Indiana	7,081,344	[2] 6,710,080	6,954,566	[2] 6,276,119	7,254,539	[2] 6,412,307	6,680,370	[2] 5,833,370
Ohio	2,355,458	4,785,766	2,147,215	4,719,092	2,178,234	3,823,209	1,866,271	3,207,286
West Virginia	5,390,181	2,473,174	3,954,472	2,241,738	2,959,032	1,530,378	2,335,864	1,310,675
New York	346,471	1,723,669	293,232	1,094,925	335,367	1,456,286	294,593	1,236,007
Kansas	824,431	824,431	659,173	659,173	356,900	356,900	332,592	332,592
Kentucky	365,611	255,736	270,871	187,000	286,243	191,062	125,745	125,745
California	120,648	120,648	67,602	67,602	79,083	79,083	86,891	86,891
Texas	14,953	14,953	18,577	18,577	20,000	20,000	8,000	8,000
South Dakota	10,280	10,280	7,255	7,255	9,817	9,817	3,500	3,500
Missouri	2,154	2,154	1,328	1,328	547	547	290	290
Colorado	[3] 2,305	[3] 2,305	1,800	1,800	1,800	1,800	1,180	1,180
Illinois	1,844	1,844	1,825	1,825	1,700	1,700	2,067	2,067

[1] From United States Geological Survey, "Mineral Resources of the United States."
[2] A portion of this was consumed in Chicago, Ill.
[3] Includes Indian Territory and Tennessee.

More than nine-tenths of the natural gas output of the United States was produced and consumed in Pennsylvania, Indiana, Ohio, West Virginia, and New York. The production was in excess of the consumption, as follows: $2,917,007 in West Virginia, $409,360 in Pennsylvania, $371,264 in Indiana, and $109,875 in Kentucky. On the other hand, the consumption exceeded the production by $2,430,308 in Ohio and by $1,377,198 in New York. Gas was supplied to Ohio from Pennsylvania, West Virginia, Kentucky, and Indiana. A comparatively insignificant amount from Canada was consumed in New York; the great bulk of the supply for this state came from Pennsylvania. Although gas was furnished to Ohio and New York from Pennsylvania, a large quantity of the gas consumed within Pennsylvania was brought from West Virginia. From Indiana gas was sent to Illinois as well as to Ohio.

In Indiana, Kansas, and Kentucky the value of the natural gas produced exceeded the value of the petroleum. The value of natural gas in Pennsylvania in 1902 was only $943,940 less than that of the petroleum product of the state. In this state the largest part of the total value of the output of natural gas and petroleum was obtained. The combined value of petroleum and natural gas in 1902 amounted to $102,265,602, and ranked next to coal in the list of the values of the crude mineral products of the United States.

The detailed statistics of the industry for 1902 are given in Table 8.

DESCRIPTIVE.

The principal elements in the composition of natural gas are carbon and hydrogen, which are combined, practically in the proportion of 75 per cent of carbon and 25 per cent of hydrogen forming CH_4, known as marsh gas or methane. This constitutes from 90 to 97 per cent of the different varieties of natural gas. The elements which go to make up the remainder are nitrogen, oxygen, carbonic acid, and hydrogen sulphide.

Occurrence.—In the United States the principal sources of natural gas so far developed are along the west flank of the great Appalachian uplift, extending from western New York to central Kentucky; also on the crest of the great Cincinnati uplift, extending from central Kentucky northward into northwestern Ohio and central Indiana; and in southeastern Kansas. The areas thus briefly described include the main natural gas fields which, in 1902, produced 99.5 per cent of the entire output of the United States.

Natural gas is found also in limited quantities in California, Utah, Colorado, South Dakota, Missouri, Texas, and Louisiana, and a considerable amount has been produced in these states, although the pools lack the area, volume, and force of those found in the Appalachian, Lima-Indiana, and Kansas fields.

East of the Mississippi river natural gas is found in the rock formation of the Paleozoic age, extending from the highest Carboniferous strata down to the stratum that is lower than the Trenton limestone, while in the West and Southwest the fields containing the gas are much more recent in the geological scale.

The reservoirs in which natural gas is usually found are composed of porous sandstone or limestone. In some cases a limited quantity of the gas has been found in shales, but this gas may be regarded as having gradually accumulated from the underlying rock formation. Almost invariably the large reservoirs have been developed in the strata on or near the crests of the anticlinal or rock waves, while petroleum has been generally collected on the lower horizon; and frequently salt water is found at a still lower level. Sometimes, however, the gas fields are entirely isolated from the petroleum producing areas. There are three leading requisites necessary for the accumulation of natural gas in merchantable quantity. These are as follows:

First. An open or porous strata capable of storing the gas under pressure.

Second. A slate or shale covering of this porous strata to seal in the upper surface and the fractures of the strata saturated with natural gas.

Third. A sufficient flexure or relief of the strata to enable the separation of the salt water and the petroleum from the natural gas.

In order that the production of the gas may be profitable, the reservoirs must be packed with high pressure gas over a large area.

The original rock pressure has been found in very many instances to equal the hydrostatic weight of a column of water of a height equal to the distance from the point where the reservoir is pierced, to the surface. If it takes 2.3 feet of head of water to equal 1 pound to the square inch, or 43 pounds to the hundred feet, then a depth of 1,000 feet will equal 430 pounds to the square inch. This proportion of the depth to the pressure has been proven to be quite near the actual results obtained.

The rock pressure and the output of gas wells are usually measured when the well is new and they are at their maximum. Even the longest life of a gas well is short, and the rock pressure decreases with every foot of natural gas taken out. It is not usual for wells having the greatest rock pressure to produce the greatest volume of natural gas, as an open pebble sand gives up its stored products more rapidly than a sand of closer texture; therefore the more open the texture of the strata, the shorter but more vigorous will probably be the life of the pool. Many pools that were most vigorous are almost entirely destitute of natural gas to-day. The gas in some of them has been so far removed by gas pumps that when they are opened the air flows into the vacuum in the porous strata once packed with high pressure gas. In many virgin fields, especially in the beds of streams, innumerable small vents and bleeders are often found, from which there is an escape of more or less natural gas in the form of bubbles. Against the hydrostatic pressure the bubbles find vent, and escape into the air. As the pressure decreases, the water usually climbs up toward the more elevated portion of the reservoir. These innumerable vents, during the ages that have passed, have acted as safety valves, and have allowed the escape of many millions of cubic feet of gas into the atmosphere. The contents of the known reservoirs are probably but a small fraction of the gas that has been dissipated in the air.

The search for and the production of petroleum, moreover, has caused a great loss of natural gas, since frequently the gas is found in the higher portion of the sand containing the petroleum, and is tapped before the petroleum is reached. In many cases the natural gas has been allowed to flow into the atmosphere and be wasted until the pressure was sufficiently exhausted to permit drilling to proceed.

In the most important fields of Pennsylvania, the original rock pressure varied from 375 to 1,000 pounds to the square inch, the average being about 700 pounds. The output of some of the largest wells in the state ranged from 7,500,000 to 25,000,000 cubic feet in twenty-four hours. A well producing about 1,000,000 cubic feet is considered a good well.

Some of the original wells in the Trenton field in Ohio gave large outputs when first opened. In the vicinity of Findlay and Bairdstown several very large wells were developed during the early history of the field, when the original rock pressure was about 450 pounds to the square inch, and several wells near the location named produced from 5,000,000 to 17,000,000 cubic feet in twenty-four hours. Now there is an average of less than 20 pounds of pressure.

The more recently developed field in Knox county near Mt. Vernon, Ohio, contains a number of wells with an output of from 5,000,000 to 9,000,000 cubic feet in twenty-four hours, the original rock pressure being about 680 pounds to the square inch. The gas in this field is found in the Clinton limestone, at a depth of about 1,850 feet.

Nearly all the natural gas produced in Indiana comes from the Trenton limestone. The wells at first were generally large producers, the output ranging from 1,000,000 to 10,000,000 cubic feet in twenty-four hours. The original rock pressure was 325 pounds to the square inch; it is now less than 70 pounds, and even this light pressure is being rapidly diminished. There are localities where the original pressure is exhausted.

In West Virginia there are a number of powerful gas wells, the productive sands of which are deeply buried. The Big Moses well, on Indian creek, Tyler county, was in its day one of the very largest wells known, and for a few years delivered immense quantities of gas. The estimated output of this well when first opened was 35,000,000 cubic feet per day. Its life was only about two years, the nearness of petroleum deposits, which were soon after developed, allowing the escape of gas and a great decline in pressure soon followed. There are numerous deep wells in West Virginia that have a rock pressure of over 1,000 pounds to the square inch; in some instances 1,500 pounds is recorded. A number of deposits of natural gas have been found in three or more distinct sands or horizons; the deepest wells measure about 3,200 feet. During the year 1900 a very large natural gas well was drilled near Goodhope, in the southern part of Harrison county. This originally had an output of 45,000,000 cubic feet per day. There are numerous wells in this section, and in the western portion of Marion and Monongalia counties there are many with a capacity of from 1,000,000 to 15,000,000 cubic feet. Wetzel county also contains powerful gas wells with a depth of from 2,700 to 3,100 feet.

Southeastern Kansas has developed very fair natural gas wells of good endurance, the rock pressure of which is from 280 to 335 pounds to the square inch.

Many of them have a volume of over 7,000,000 cubic feet per day, the depth being about 900 feet.

Historical. The existence of natural gas was discovered through the observation of bubbles in springs and streams, many of which would sustain a flame for an indefinite period. These springs and natural vents were known to the early pioneers, while for centuries before they had been known to the Indians, who viewed them with a certain amount of awe and veneration, since they cast a weird light at night upon their camping grounds.

The white men drilling wells for salt brine were in many instances surprised by the outburst of imprisoned natural gas when their crude drills penetrated the sealed-in reservoirs. These outbursts were often of sufficient violence to blow out the drilling tools, and in some instances they ignited and destroyed the primitive drilling plant.

In subsequent years the search for petroleum developed many pools of natural gas of high pressure, and in the early development of petroleum the finding of this gas was considered a dangerous and unwelcome discovery, although it was known and utilized in a few localities long before the first well was drilled for petroleum in 1859.

Natural gas has been developed almost entirely in the northeastern portion of the United States, there being only a few wells, comparatively, in the west and southwest portions. In Canada some has been found, a part of which has been consumed in the United States. Although natural gas is distributed largely over the entire globe, its development and use outside of the United States and Canada has been insignificant. There is at present a small consumption of natural gas in England, in Sussex county. Holland makes use of it for the partial illumination of two small villages on the Zuyder Zee. Galicia, Roumania, Russia, India, Persia, and Japan use it in a limited way in the operation of petroleum wells and in refineries.

One of the most noted natural gas vents or springs located by the pioneers was on the northern bank of the Kanawha river, in West Virginia; this spring was visited in 1776 by General Washington, who was greatly impressed by the phenomenon. There was also a well-known gas spring on the Big Sandy river 50 miles above its mouth; and numerous springs were known to exist on what has been called the St. Marys uplift, which extends 25 miles north from Burning Springs on the Little Kanawha river. In the early history wells drilled for salt water in the area extending from the Cumberland river, Ky., to above the mouth of the Kiskiminitas on the Allegheny river, very often developed large flows of natural gas. In some cases the flow of these wells was persistent, in other cases it was soon exhausted.

The earliest economic use of natural gas in this country was, in all probability, in 1821, when it was used in the lighting of the village of Fredonia, Chautauqua county, N. Y. On the banks of the Canadaway creek, on which Fredonia is situated, a well 1½ inches in diameter was drilled to a depth of 27 feet, and from this was obtained a flow of natural gas sufficient for 30 burners, the light of each of which was considered to be equal to that of two good candles. Several years later, in 1825, a small gasometer was introduced, and afterwards a number of shallow wells were drilled, and from these more or less natural gas was secured. In 1871 a well developed a very large flow of natural gas when at the depth of 1,200 feet it pierced the Corniferous limestone.

A well dug for water at Findlay, Ohio, in 1838 produced large quantities of natural gas near the crest of the great Cincinnati uplift. The gas was collected and conveyed into the house of Mr. Daniel Foster, where it was utilized for nearly fifty years, until the regular development of the great Findlay gas field began in November, 1884.

In 1841 natural gas was developed in association with salt brine in a well drilled on the Kanawha river in West Virginia, near where an original gas spring was located. The pressure was sufficient to force the salt brine up into a large hogshead where the salt and gas were separated. The salt brine was diverted into salt pans and the gas conducted to the furnaces underneath, where it was successfully used as fuel for the evaporation of the salt water.

More or less gas was developed on Oil creek, Pa., and in the surrounding section, by the wells drilled in the search for petroleum in the winter of 1859 and 1860. Some of these wells produced gas only, and others produced both gas and petroleum. For several years it was the common practice to conduct the gas to a safe distance and there consume it to get it out of the way. The high price of coal and wood and the extremely poor roads, finally induced some of the more venturesome to try to burn it under boilers. This experiment was so great a success that natural gas became a most efficient substitute for coal and wood. In its early application, however, numerous fires and explosions were caused by overpressure, because at that time no automatic method of regulating the pressure was known.

One of the first applications of natural gas for fuel purposes was in the year 1868, when a manufacturing company in Erie, Pa., drilled a well 600 feet deep into the Devonian shale. This well produced a considerable amount of gas when first opened, but the output gradually declined. Many wells that were sufficiently large to supply one or two dwellings were afterwards drilled in this locality.

Near Titusville, Pa., in 1872, thirteen years after the drilling of the first oil well, a powerful natural gas well was drilled on the Newton farm, 5½ miles north of the town. The gas from this well was conveyed into the town by a 2-inch gas main, which furnished 250 consumers with light and fuel. Afterwards the original line was reinforced by a second one 3¼ inches in diameter. The two lines maintained a steady pressure and a satisfactory supply. This was the first natural gas plant which supplied light and heat in any large and permanent quantity by methods and appliances similar to those in use to-day. It is looked upon as the beginning of the industry which has since assumed such large proportions.

During the year 1873 natural gas was successfully introduced for fuel and light at numerous localities in Venango, Butler, and Armstrong counties. It was also introduced at Leechburg, in Armstrong county, in the same year, the supply being obtained from an abandoned well drilled for oil in 1871, and was successfully applied in heating and puddling furnaces.

Iron mills at Etna, near Pittsburg, Pa., were the first large mills to be supplied by a gas line of any considerable length. The supply was used for years. This line was built in 1875, and extended from the iron mills to the Harvey well, near Lardens mills in Butler county, a distance of 17 miles. This well was one of the largest known at that time.

By the close of 1883 several pipe lines were supplying the manufacturing establishments and the domestic service in Pittsburg, Pa., the supply being from the Murrysville pool, in Westmoreland county, which had been developed several years previously. In 1885 the Grapeville and the Speechley pools were first developed. The increase in its use was remarkable, and a number of pools in Washington, Butler, and Beaver counties were opened up and connected by pipe lines. In 1886 the gas field at Findlay, Ohio, began to be prominent. Afterwards a large field in Indiana was developed. The development of these large reservoirs of natural gas, hitherto unknown, seemed to impress the general public and many of the operators of natural gas fields with the idea that these reservoirs were practically inexhaustible. The fact that the quantity of gas withdrawn from any of the large fields by one or two wells decreases the volume and pressure very slowly caused a false impression as to the extent of the reservoirs. As the fields were developed, however, and many wells reached the gas reservoirs, the decline in the pressure became more rapid and noticeable.

In Pennsylvania, Ohio, and Indiana immense quantities of gas were consumed in wasteful and extravagant display, which in numerous instances almost turned night into day. This extravagance was not realized until the fields began to be seriously depleted. In the mills and factories the application of gas as a fuel was made in a wasteful and unscientific manner; at least double the quantity of gas necessary to do a given amount of work was consumed.

In 1890 and 1891 many reforms tending to improve methods of storing, transporting, and consuming natural gas were inaugurated. The meter was introduced, which at once made it to the interest of the consumer to see that consumption was economical. The wells were controlled from the head office by telephones, so that when the supply was more than enough the gates at the wells were shut. The wells were watched more vigilantly, salt water was kept out with more care, and leaks and joints and all pipe connections were carefully examined and repaired. The use of large pipes by many of the gas companies began about this time, enabling them to send larger quantities to points of consumption at reduced pressure.

Uses.—Natural gas is used principally as a source of light and heat in domestic service. It is employed extensively in industrial establishments for many purposes, notably in the manufacture of glass, in the generation of steam, puddling of iron, in roasting ores, in heating furnaces, and in the manufacture of steel, and it is also utilized as a source of power in the gas engine, in drilling and operating oil and gas wells, and in pumping oil. The heat value stored in natural gas is greater than that caused by any artificial combination of carbon and hydrogen, and is a perfect fuel as it issues from its original rock-sealed reservoirs. No preparation is necessary for its combustion and no residue is left. It is not affected by ordinary temperature and it is easily distributed by pipes to points of consumption. It is a most economical source of light and power, and an ideal household fuel.

The illuminating properties of natural gas vary in different localities, because of the difference in the percentage of the heavier hydrocarbon, ethane (C_2H_6). All the natural gas found adjacent to petroleum fields has a larger proportion of ethane than the gas farther removed, and therefore the candlepower is considerably greater. Ordinary natural gas, if consumed with a common tip at the rate of 7 or 8 cubic feet per hour, will yield about 6 or 7 candlepower. In an ordinary Argand burner with chimney, it will give about 12 candlepower in consuming 5 to 6 cubic feet per hour. When natural gas is consumed in contact with a mantle of alkaline earth (thoria, etc.), the result is the cheapest and best illuminant known. When the price of natural gas is 25 cents per 1,000 cubic feet, and 50 candlepower is obtained from a consumption of 2½ cubic feet per hour, the cost per candlepower per hour is only 0.00125 of a cent.

There were 510,000 domestic consumers of natural gas during 1902, and it is estimated that in the western portions of New York and Pennsylvania, in central and western West Virginia, and in Ohio, Indiana, and Kansas, not less than 4,500,000 persons received the benefit of natural gas used as a fuel and an illuminant. Over 8,000 manufacturing establishments were also supplied.

The introduction of natural gas into the household, for which it is eminently fitted, has been accomplished without personal inconvenience or loss of life, except in very rare cases. The risk from fire is less than when wood and coal are used. There have been some cases of asphyxiation when a stove has been burned in a room without a flue connection, as it has been found by experiment that combustion under these conditions is imperfect, especially so if the air in the room becomes more or less saturated with carbonic acid and the vapors of water, the result being the formation of poisonous carbonic oxide.

The calorific value of natural gas varies slightly in different localities, as the amounts of carbon and hydrogen vary. Those natural gases which contain the highest percentage of carbon give the best results in evaporating water. The standard used in measuring the evaporation of water is called the British Thermal Unit, written B. T. U., and is the amount of heat necessary to raise 1 pound of pure water 1° F. at or near 39°, which is the temperature of the maximum density of water. The quantity of air necessary for the perfect combustion of natural gas varies from 10.4 to 10.8 parts of air to 1 part of natural gas. The products of combustion are water and carbonic acid.

The ultimate heat units in any fuel are not all available for the conversion of water into steam, a proportion being lost by radiation and in causing sufficient draft to supply the fresh air that is required to keep up the combustion. A number of tests have fully demonstrated that when ordinary care is taken in burning natural gas under boilers in actual service, 1 cubic foot of natural gas will do the work equivalent to the evaporation of 1 pound of water at and above 212° F. Since 20 cubic feet of ordinary natural gas weigh 1 pound, 1 pound of natural gas will evaporate 20 pounds of water, while, under similar conditions, 1 pound of petroleum will evaporate only 16 pounds of water, and 1 pound of good coal will evaporate but 10 pounds of water; therefore 10 cubic feet of gas is equal to 1 pound of coal, or 20,000 cubic feet will equal 1 ton of coal.

Only two articles have been made directly from natural gas; they are lampblack and gas coke. Lampblack is still made, but gas coke ceased to become a product when natural gas as a fuel was consumed in an economical manner. In isolated districts, where it is difficult to convey the natural gas to market, numerous wells have been made profitable by the conversion of the gas into lampblack. The process is extremely wasteful, as the amount of carbon actually secured is probably not more than one-twentieth of the carbon contained in the gas consumed. In the manufacture of lampblack or carbon black a great number of small jets are made to impinge upon a pipe, through which there is a circulation of water to keep it cold. The carbon is deposited on the pipes in very thin films and accumulates very slowly. Automatic scrapers and brushes are arranged to collect the deposit, so that the flames can have the clean, cold surface of the pipes upon which to deposit a fresh supply. The lampblack thus secured is said to be the very finest, and is used extensively at home and abroad.

Gas coke is a product of the imperfect combustion of natural gas when the unconsumed portion is highly heated. Under such condition the gas is decomposed and pure carbon is deposited. Generally the deposit was obtained from the fire boxes of the heating furnaces used in the manufacture of wrought iron, and found a ready sale for use in the manufacture of electric light carbons. It is similar in appearance to the coke formed from coal, and has a metallic ring when struck with a hammer.

The measurement of the output of gas wells.—To ascertain the outflow of a gas well in cubic feet per hour it is necessary to determine the momentum, either by the application of the Pitot tube or, if the pressure is greater than 5 pounds, by the use of an accurate steam gauge. In using the Pitot tube one end of a shoot pipe is placed at right angles to the flow from the well and as nearly even with the orifice of the pipe as possible one-third of the diameter from the outer edge. Leading away from this small nipple there is an elbow and a piece of pipe attached to a siphon gauge, in which the gas presses against the water or mercury. There is also a scale attached to the gauge showing the inches and tenths of an inch of the height of the column caused by the momentum. This method of application and the formula for determining the flow were first applied by Prof. S. W. Robinson, of the Ohio State University.

Compressors.—The pressure in most of the original fields at first was ample to convey large quantities of gas a number of miles through medium sized pipes. In after years a gradual reduction in the pressure made it necessary to install powerful compressing machinery. At first gas was used in the generation of steam as a motive power; afterwards the most successful and economical compressors were those in which gas was exploded directly in the cylinder.

Many of these compressor plants installed by the natural gas companies are models of the highest mechanical efficiency, some of the individual compressors developing as much as 2,000 horsepower and weighing from 250 to 500 tons. The more recent ones are so constructed as to use natural gas engines instead of steam engines for motive power. By the operation of compressors with the gas engine there is a saving of from 40 to 50 per cent in the amount of gas used, as compared with that consumed under boilers supplying double expansion engines. One of the first gas compressor plants using natural gas as a motive power is in use at Halsey, McKean county, Pa. This plant consists of four horizontal gas cylinders, in which natural gas is exploded, each having a diameter of 25 inches and a stroke of 4 feet. These cylinders are set tandem, two on each side of the main shaft, which carries two 13-foot fly wheels and operates four compressor cylinders. Two of these cylinders are high-stage compressors and two are low-stage compressors, the former being 15 inches in diameter and the latter 31 inches in diameter; the stroke is 2 feet. The main dimensions are: Length, 75 feet, and breadth at fly wheel, 18 feet. In this engine one horsepower per hour is produced by the consumption of 9 cubic feet of natural gas.

The natural gas engine.—Since the first successful use of the natural gas engine about ten years ago, its application has been rapid as well as eminently successful; wherever natural gas could be secured this engine has been installed, and has fully demonstrated its economy and reliability. One of its greatest triumphs is that it dispenses with the costly and extravagant boiler.

Its merits are fully demonstrated in its application to the pumping of petroleum wells and the operation of the smaller force pumps used in the transportation of the petroleum. Its general introduction into the petroleum producing fields has enabled the operator to pump economically small wells that otherwise could not be operated, and it has also enabled him to handle large quantities of water where petroleum must be secured at a small outlay. Petroleum wells are often pumped in clusters of from 5 to 25, the number varying according to the depth and other conditions. Where the wells are comparatively shallow, and not too far apart, they can be pumped readily and with small loss by means of rods operated by steam or gas engines. Formerly deep wells were operated by a single boiler in or near the center of a cluster of from 4 to 6 wells, each of which had a steam engine connected with steam pipes radiating from this boiler. The loss by condensation when this method was used was very great.

The gas engine has in many instances replaced the steam engine, the change often being effected by the removal of the steam cylinder and the substitution of a gas cylinder. The boiler is dispensed with. The gas engine will run unattended for hours, as it is only necessary that it be kept lubricated. The steam engines usually employed in petroleum operations are generally not well cared for, so that the steam used for the work accomplished is often extravagant. In ordinary practice the internal combustion engine, of which the natural-gas engine is a type, is most economical, and equals in effectiveness the triple expansion condensing engine. When the natural gas engine is operated in the most economical manner, there is a saving of nearly 50 per cent in fuel over that required to be consumed under boilers to operate high duty steam engines, and a saving of about 90 per cent over the consumption required for the ordinary steam engine.

Distribution of natural gas to the consumer.—Almost the entire production of natural gas is distributed to the consumers by wrought iron pipes, which vary from 1 inch to 20 inches in diameter. There are also in use a number of miles of riveted wrought iron pipes of a diameter of 3 feet. Lately many long lines have been constructed of pipe 18 and 20 inches in diameter. The pressure at the field end of these lines is in some instances as high as 400 pounds to the square inch, but it is usually from 100 to 200 pounds. Where the natural well pressure is not sufficient, it is increased by large compressors, before described.

Wrought iron pipes 6 inches and less in diameter are usually connected by collars with threaded joints. Recently the joints for the larger diameters have been made of sleeves of a larger diameter, between which and the pipe rubber packing is forced by flanges drawn together by bolts. This variety of joint is satisfactory in every way, and has a number of advantages over the screw couplings for larger diameters. It overcomes the trouble due to the expansion and contraction of the pipe line without a resort to fine bends; it enables the pipe to swing more or less; it adjusts itself to the inequalities of the surface; it cheapens the first cost, because no threads have to be cut; it is not so easily injured in transportation, and it is efficient in preventing disintegration by electrolysis in localities where electric roads are operated. Usually the main line pressure is reduced near the city or town line to a pressure of from 20 to 50 pounds, and the gas is fed into an intermediate system of pipes supplying the regulators that deliver the natural gas into the mains from which the consumers are supplied.

In the cities and towns there are two methods of distribution. The more common system is called the low pressure system, and usually carries a pressure of from 3¼ to 7 ounces to the square inch. This system consists of a series of pipes from 2 to 12 inches in diameter laid in the street at a depth of from 2½ to 3 feet, the largest sizes being placed in the localities of the greatest consumption. To these pipes are connected the service pipes, which are usually from 1 to 1½ inches in diameter, and lead into the consumers' houses. Between the high pressure lines and the low, automatic regulators are placed, adjusted by weights and diaphragms, in such a manner that the pressure remains almost constant, even when more or less natural gas is conveyed from the high to the low pressure. A series of liquid seals are used in connection with most of the regulators, which prevent any pressure over 16 ounces on the low side from getting into the dwellings; the liquid seals will blow out when such pressure is reached.

Another system is that of placing a reducing valve inside or near each house, this valve being connected with a smaller pipe conveying a higher pressure which is reduced by an individual regulator to a pressure of from 4 to 6 ounces. The points of consumption are in many instances from 100 to 250 miles distant from the place of production.

The total length of pipes of all sizes from 2 inches up to 36 inches in diameter in use in the United States for conveying natural gas at the close of 1902 was 131,859,636 feet. This is equal to 24,973.41 miles—enough to more than girdle the earth at the equator.

Natural gas is usually sold to the consumer by the cubic foot, at a standard pressure of 4 ounces to the square inch, or 36 pounds to the square foot, at a temperature of 60° F. In many instances it is convenient to dispose of the gas to consumers at higher pressures, and then it is necessary to construct meters of proportional strength. The mean pressure of the atmosphere for the elevation at which most of the natural gas is sold is assumed to be 14.4 pounds to the square inch.

TABLE 8.—DETAILED

		United states.	California.	Illinois.	Indiana.
1	Number of wells	15,8[illegible]	29	28	6,861
2	Number of operators	1,967	15	23	880
	Character of ownership:				
3	Individual	980	6	22	341
4	Firm	276	2	1	158
5	Incorporated company	651	6		337
6	Other form	60	1		44
	Salaried officials, clerks, etc.:				
7	Total number	1,923	10		580
8	Total salaries	$1,810,337	$11,940		$447,508
	General officers—				
9	Number	386	4		157
10	Salaries	$560,575	$3,600		$155,484
	Superintendents, managers, foremen, surveyors, etc.—				
11	Number	791	4		221
12	Salaries	$723,085	$7,080		$177,108
	Clerks—				
13	Number	746	2		202
14	Salaries	$526,677	$1,260		$114,916
	Wage-earners:				
15	Total average number	4,678	21		938
16	Total wages	$2,937,279	$10,800		$586,860
	Engineers, firemen, and other mechanics—				
17	Average number	1,547			354
18	Wages	$1,165,448			$272,555
	Boys under 16 years—				
19	Average number	2			
20	Wages	$925			
	All other wage-earners—				
21	Average number	3,129	21		584
22	Wages	$1,770,906	$10,800		$314,305
	Average number of wage-earners at specified daily rates of pay:				
	Engineers—				
23	$0.75 to $0.99	1			
24	$1.00 to $1.24	5			4
25	$1.25 to $1.49	1			4
26	$1.50 to $1.74	51			46
27	$1.75 to $1.99	30			20
28	$2.00 to $2.24	80			32
29	$2.25 to $2.49	38			17
30	$2.50 to $2.74	57			48
31	$2.75 to $2.99	14			5
32	$3.00 to $3.24	22			5
33	$3.25 to $3.49	3			1
34	$3.50 to $3.74	1			1
35	$3.75 to $3.99	26			1
36	$4.00 to $4.24	9			2
37	$4.25 and over	2			1
	Firemen—				
38	$1.25 to $1.49	14			12
39	$1.50 to $1.74	30			27
40	$1.75 to $1.99	30			6
41	$2.00 to $2.24	21			21
42	$2.25 to $2.49	19			2
43	$2.50 to $2.74	1			1
44	$3.50 to $3.74	1			
45	$4.00 to $4.24	1			
46	$4.25 and over	1			
	Machinists, blacksmiths, carpenters, and other mechanics—				
47	$0.50 to $0.74	1			1
48	$0.75 to $0.99	2			
49	$1.00 to $1.24	2			
50	$1.25 to $1.49	8			2
51	$1.50 to $1.74	51			7
52	$1.75 to $1.99	118			29
53	$2.00 to $2.24	129			21
54	$2.25 to $2.49	195			3
55	$2.50 to $2.74	121			8
56	$2.75 to $2.99	37			
57	$3.00 to $3.24	35			16
58	$3.25 to $3.49	5			
59	$3.50 to $3.74	14			4
60	$3.75 to $3.99	1			
61	$4.00 to $4.24	18			5
62	$4.25 and over	37			2
	Boys under 16 years—				
63	$0.75 to $0.99	1			
64	$1.00 to $1.24	1			
	All other wage-earners—				
65	$0.50 to $0.74	1			
66	$0.75 to $0.99	7			1
67	$1.00 to $1.24	20			7
68	$1.25 to $1.49	222	19		30
69	$1.50 to $1.74	1,098			258
70	$1.75 to $1.99	686	2		151
71	$2.00 to $2.24	560			67
72	$2.25 to $2.49	306			59
73	$2.50 to $2.74	144			8
74	$2.75 to $2.99	21			1
75	$3.00 to $3.24	10			2
76	$3.50 to $3.74	12			
77	$3.75 to $3.99	10			
78	$4.00 to $4.24	6			
79	$4.25 and over	26			

SUMMARY: 1902.

Kansas.	Kentucky.	Missouri.	New York.	Ohio.	Pennsylvania.	South Dakota.	Texas.	West Virginia.	All other states and territories.[1]	
414	117	13	612	1,352	5,408	6	11	949	3	1
57	19	9	108	417	363	3	2	63	5	2
12	11	8	73	340	157	1	1	4	1	3
3	2		6	12	78	1	1	12		4
37	6	1	29	59	126			46	1	5
5				6	2	1		1		6
13	32	1	76	241	718		1	221		7
$52,012	$34,270	$232	$63,015	$221,837	$769,042		$2,000	$225,501		8
19	11		11	33	119			32		9
$15,435	$18,780		$11,530	$55,630	$231,483			$65,733		10
16	13		33	82	305		1	119		11
$10,777	$8,990		$26,604	$78,990	$305,586		$2,000	$106,950		12
11	8	1	32	126	291			70		13
$5,800	$6,480	$232	$24,881	$87,217	$252,073			$53,818		14
100	81		121	639	2,125			634		15
$65,952	$27,560		$84,476	$441,581	$1,308,205			$410,845		16
36	7		99	103	518			130		17
$36,642	$5,420		$72,721	$278,152	$402,811			$98,244		18
2										19
$625										20
62	13		22	296	1,567			504		21
$29,785	$22,140		$11,755	$163,429	$905,301			$312,601		22
1										23
				1						24
										25
1	2			1	1					26
			2	1	14			2		27
1			1	6	40					28
			1	1	15			4		29
2				3	2			2		30
					9					31
					16			1		32
				1	1					33
										34
					25					35
				3	1			3		36
					1					37
					2					38
	1				2					39
			2	11	11					40
										41
					17					42
				1				2		43
					1					44
					1					45
								1		46
										47
				1	1					48
			1					1		49
1				1	2			2		50
			15	2	10			14		51
1	1		6	53	44			11		52
1	2		23	133	178			19		53
1			7	158	14			11		54
2			30	17	38			16		55
			9	8	15			5		56
			1	2	9			1		57
2				1	2					58
3				5	2					59
					1					60
2			1		7			3		61
	2			3	26			2		62
1										63
1										64
					1					65
			2		3			1		66
			1	6	6					67
22	30			18	102			1		68
26			4	94	666			50		69
2			2	76	293			160		70
12			13	84	216			168		71
				5	182			60		72
	18			8	65			60		73
					9			11		74
				1	5			2		75
				2	9			1		76
					10					77
					6					78
				2	24					79

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[1] Includes operators distributed as follows: Colorado, 3 (wells included with petroleum); Indian Territory, 1; Tennessee, 1 (2 wells).

		United States.	California.	Illinois.	Indiana.
	Average number of wage earners employed during each month:				
	Men 16 years and over—				
80	January	3,819	21		913
81	February	3,575	21		875
82	March	3,631	21		882
83	April	3,842	21		931
84	May	4,112	21		909
85	June	4,371	21		929
86	July	4,634	21		924
87	August	5,082	21		941
88	September	6,668	21		1,075
89	October	5,493	21		1,031
90	November	5,530	21		948
91	December	6,335	21		911
	Boys under 16 years—				
92	January	2			
93	February	2			
94	March	2			
95	April	2			
96	May	2			
97	June	2			
98	July	2			
99	August	2			
100	September	2			
101	October	2			
102	November	2			
103	December	2			
	Contract work:				
104	Amount paid	$4,459,001	$12,300	$1,317	$1,046,444
105	Number of employees	5,268	2	12	1,267
	Miscellaneous expenses:				
106	Total	$5,912,257	$15,757	$94	$1,399,355
107	Royalties and rent of mine and mining plant	$2,533,895			$539,844
108	Rent of offices, taxes, insurance, interest, and other sundries	$3,378,362	$15,757	$94	$859,511
109	Cost of supplies and materials	$6,607,255	$13,698		$1,029,358
110	Value of product	$30,867,803	$120,648	$1,844	$7,091,844
	Power:				
111	Total horsepower	104,107	233		67,099
	Owned—				
	Engines—				
	Steam—				
112	Number	787			189
113	Horsepower	94,595			60,796
	Gas or gasoline—				
114	Number	300	1		74
115	Horsepower	7,083	8		4,288
	Other power—				
116	Number	12			9
117	Horsepower	2,162			2,000
	Rented—				
118	Electric, horsepower	225	225		
119	Other kind, horsepower	42			15
	Electric motors owned—				
120	Number	6	1		2
121	Horsepower	20	10		10
122	Supplied to other establishments, horsepower	10			10

SUMMARY: 1902—Continued.

Kansas.	Kentucky.	Missouri.	New York.	Ohio.	Pennsylvania.	South Dakota.	Texas.	West Virginia.	All other states and territories.	
79	49		96	342	1,994			325		80
78	49		90	288	1,883			291		81
78	49		96	285	1,903			510		82
80	49		110	294	1,962			449		83
99	50		103	466	1,993			470		84
98	50		102	489	2,181			801		85
100	49		104	512	2,215			697		86
111	49		129	740	2,329			752		87
117	53		165	985	2,113			830		88
128	53		176	1,150	2,197			737		89
99	52		148	1,154	2,161			744		90
100	48		133	1,693	2,226			1,198		91
2										92
2										93
2										94
2										95
2										96
2										97
2										98
2										99
2										100
2										101
2										102
2										103
$107,868	$9,297	$950	$77,904	$433,036	$1,745,500	$7,943	$18,812	$994,640	$3,000	104
128	22	7	97	415	988	5	17	298	10	105
$10,100	$112,794	$501	$127,580	$491,223	$2,809,683		$2,612	$822,619		106
$21,038	$8,725		$52,439	$198,671	$1,253,278		$2,052	$507,868		107
$19,071	$101,069	$501	$85,091	$292,552	$1,676,355		$580	$314,771		108
$165,859	$57,197	$600	$59,930	$1,139,201	$2,687,228		$125	$1,495,069		109
$824,431	$305,611	$2,154	$546,471	$2,355,458	$14,352,183	$10,290	$14,953	$5,390,181	$2,305	110
230	649		956	4,135	22,041		22	8,742		111
7	6		5	33	226		1	250		112
218	600		585	1,405	20,296		22	8,673		113
	2		5	57	146			13		114
	37		371	505	1,745			69		115
	1			2						116
	12			150						117
										118
12				15						119
					3					120
					30					121
4										122

STONE

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STONE.

By George P. Merrill, Ph. D.

As early as the Seventh Census, statistics of the production of stone for building and decoration were shown. Under the name of "stone and marble quarries" a total of 1,144 quarries, with an output valued at $8,180,115, was reported. This, however, did not include the value of stone burned into lime, which was separately reported and amounted to $2,286,242. There were also 5 slate quarries, with a product valued at $29,056. Statistics for slate and marble quarries have been shown at each subsequent census, but the first systematic and fairly satisfactory report of the stone industry, as a whole, was begun under the direction of Dr. George W. Hawes at the time of the Tenth Census in 1880. The unfortunate death of Doctor Hawes, in the midst of his labors, prevented the carrying out of his plans as completely as might have been desired, but enough was accomplished to establish a basis for future work and furnish material for comparison.

It will be noted that since 1880 the increase in number of quarries was 4,239, and in value of products, $52,086,383. The industry has, therefore, practically quadrupled during the twenty-two years. No comparison can be made between the wages for 1880 and those for 1902, as wages were not reported in 1880; the increase in salaries and wages from 1889 to 1902, however, was $11,448,369, or 37.5 per cent.

The following table presents comparative statistics for all classes of stone for 1902, 1889, and 1880:

Table 1.—*Comparative summary: 1880 to 1902.*

	1902	1889[1]	1880
Number of quarries	5,764	4,163	1,525
Number of operators	5,470	(2)	(2)
Salaried officials, clerks, etc.:			
Number	3,279	[3]1,086	(2)
Salaries	$4,188,339	(4)	(2)
Wage-earners:			
Average number	71,156	[3]61,288	[5]39,723
Wages	$37,615,907	[4]$30,355,877	(2)
Miscellaneous expenses	$3,976,865	$2,283,706	(2)
Cost of supplies and materials	$10,739,736	$7,323,220	[6]$192,175
Value of product	[7]$70,462,438	[8]$53,035,620	$18,376,055

[1] Exclusive of silica sand.

[2] Not reported.

[3] Foremen included as wage-earners.

[4] Salaries included in wages.

[5] Greatest number employed.

[6] Value of explosives.

[7] The United States Geological Survey reports under "glass sand" (this is not included in stone) 943,135 short tons, valued at $807,797, which includes glass sand obtained from banks. Census figures for "silica sand," included in stone, are $121,289 for the value of the product, and embrace only the sand produced at sandstone quarries by crushing the rock. The production of stone reported by the survey does not include limestone, valued at $210,798, consumed in the manufacture of cement.

[8] Includes bluestone, purchased by wholesale dealers, valued at $939,094.

Capital stock of incorporated companies.—Of the 5,470 operators of stone quarries, 754 were incorporated companies. Details of capitalization were reported by 675 of these, and are shown, by classes of stone, in the following table:

Table 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	Total	Limestones and dolomites.	Marble.	Sandstones and quartzites.	Silica sand.	Siliceous crystalline rocks.	Slate.
Number of incorporated companies	754	344	45	119	10	176	60
Number reporting capitalization	675	311	43	104	9	153	55
Capital stock and bonds issued	$103,347,650	$35,509,735	$20,318,400	$16,219,850	$595,275	$19,280,825	$11,423,565
Capital stock							
Total authorized—							
Number of shares	6,112,267	2,523,008	1,556,000	821,302	25,200	645,183	541,574
Par value	$107,193,740	$34,668,900	$20,414,000	$14,551,600	$655,000	$20,286,800	$16,617,440
Total issued—							
Number of shares	5,244,389	2,182,612	1,448,338	777,765	21,741	505,848	308,085
Par value	$89,516,050	$30,165,235	$17,609,900	$13,821,350	$554,175	$16,907,325	$10,458,065
Dividends paid	$1,762,332	$751,534	$239,250	$276,956	....	$383,438	$111,154
Common—							
Authorized—							
Number of shares	5,760,783	2,445,658	1,519,300	820,802	25,200	640,623	309,200
Par value	$93,505,200	$30,594,400	$16,744,000	$14,526,600	$655,000	$19,828,300	$11,156,900
Issued—							
Number of shares	5,121,478	2,141,391	1,413,748	777,353	21,741	502,313	264,932
Par value	$82,362,025	$27,554,775	$14,151,900	$13,800,750	$554,175	$16,550,325	$9,750,100
Dividends paid	$1,562,452	$681,353	$139,250	$275,732	....	$383,438	$82,679
Preferred—							
Authorized—							
Number of shares	351,484	77,350	36,700	500	....	4,560	232,374
Par value	$13,688,540	$4,074,500	$3,670,000	$25,000	....	$458,500	$5,460,540
Issued—							
Number of shares	122,911	41,221	34,590	412	....	3,535	43,153
Par value	$7,154,025	$2,610,460	$3,458,000	$20,600	....	$357,000	$707,965
Dividends paid	$199,880	$70,181	$100,000	$1,224	....	....	$28,475
Bonds—							
Authorized—							
Number	46,213	10,433	8,758	3,900	411	20,220	2,491
Par value	$18,386,100	$6,206,500	$4,475,000	$2,586,000	$41,100	$3,752,000	$1,325,500
Issued—							
Number	25,683	8,822	1,874	2,542	411	10,250	1,784
Par value	$13,831,600	$5,344,500	$2,708,500	$2,398,500	$41,100	$2,373,500	$965,500
Interest paid	$576,901	$258,362	$83,290	$108,485	$2,466	$89,873	$34,425
Assessments levied	$176,950	$2,000	$15,000	$3,000	....	$148,500	$8,450

Capital stock and funded debt amounting to $103,347,650 was reported for all classes of stone, of which $35,509,735, or 34.4 per cent, was invested in quarries of limestones and dolomites; $20,318,400, or 19.7 per cent, in marble quarries; $19,380,825, or 18.7 per cent, in quarries of siliceous crystalline rocks; $16,219,850, or 15.7 per cent, in quarries of sandstones and quartzites; $11,323,565, or 11 per cent, in slate quarries; and $595,275, or five-tenths of 1 per cent, in quarries of silica sand.

The following table shows the number of operators, grouped by value of product, with the percentages the number and value are of the totals:

TABLE 3.—*Operators by value of product: 1902.*

PRODUCT PER OPERATOR.	OPERATORS.		VALUE OF PRODUCT.[1]	
	Number.	Per cent of total.	Amount.	Per cent of total
Total	5,470	100.0	$71,204,313	100.0
Less than $500	1,789	32.7	322,752	0.4
$500 but less than $1,000	498	9.1	357,244	0.5
$1,000 but less than $10,000	1,868	34.2	7,386,261	10.4
$10,000 but less than $50,000	1,004	18.3	22,580,841	31.7
$50,000 but less than $100,000	188	3.4	13,612,105	19.1
$100,000 but less than $250,000	100	1.8	16,548,981	23.3
$250,000 but less than $500,000	20	0.4	8,280,936	11.6
$500,000 and over	3	0.1	2,115,180	3.0

[1] Includes abrasive materials valued at $741,875 produced by operators of stone quarries, but not included in the value shown in Table 1.

Although not clearly shown by the statistics, it is nevertheless true that there exists in the stone industry the same tendency toward the concentration of capital and the formation of stock companies as in other branches of trade, though possibly not to the same extent. This is due not altogether to the desire for combination with a view to controlling trade, but in part at least to a change which has taken place in the character of the industry. The introduction of machinery, often of an expensive type, for both quarrying and dressing, renders necessary a larger initial outlay than in the earlier days of the industry when hand labor alone was employed. The fact, too, that the quarrier in many cases now contracts not merely to furnish the stone, but to furnish it cut and ready for its definite position in the structure, even if he does not contract to set it in place as well, involves a larger capitalization and supply of available funds.

Of the operators shown in the foregoing table 5.7 per cent reported a product valued at $50,000 or more, the value of their combined product constituting 57 per cent of the total; 94.3 per cent reported a product valued at less than $50,000, their combined value of product constituting 43 per cent of the total.

Employees and wages.—The following table shows the average number of wage-earners employed each month:

TABLE 4.—*Average number of wage-earners employed during each month: 1902.*

MONTH.	Wage-earners.
January	49,859
February	50,216
March	60,019
April	72,695
May	79,029
June	81,622
July	83,313
August	83,907
September	82,811
October	79,809
November	70,852
December	59,710

The minimum number, 49,859, was reported for January, and the maximum, 83,907, for August. The variation in the numbers employed during the summer and winter months is readily explained when it is remembered that quarrying is an outdoor pursuit and the severity of the northern winters practically puts a stop to all building and outdoor work. The comparatively recent developments in the Southern states, where the climatic conditions are less severe, have rendered this discrepancy much less marked than in times past.

In Table 5 the figures for the number of wage-earners at specified daily rates of pay in the several kinds of stone quarries are combined, and the totals for all stone quarries are given for the different classes of employees. In addition to the average number of wage-earners included in each rate group, the percentages which these numbers form of their respective totals are shown.

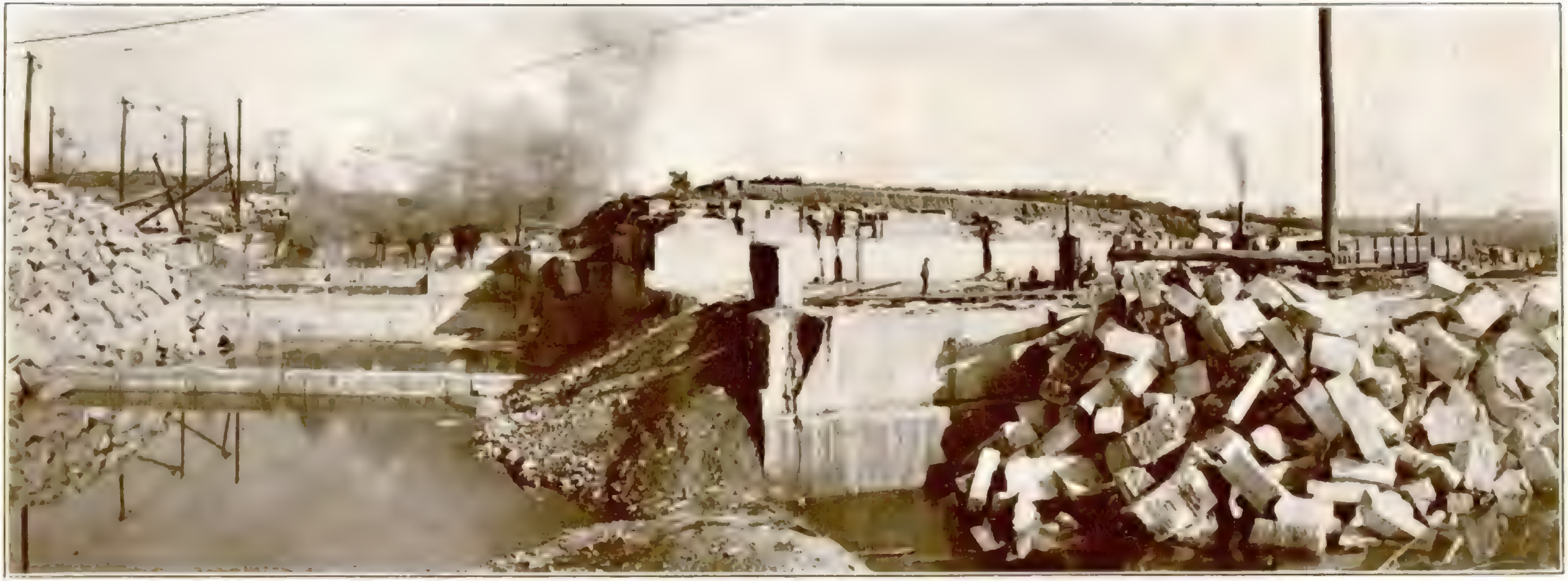

PLATE I.—QUARRY IN OOLITIC LIMESTONE, BEDFORD, INDIANA.

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TABLE 5.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1]71,156	100.0	2,540	100.0	933	100.0	2,976	100.0	49,945	100.0	731	100.0	14,031	100.0
Less than 0.50	70	0.1									69	9.4	1	(2)
0.50 to 0.74	458	0.6	5	0.2	4	0.4	2	0.1	100	0.2	257	35.2	90	0.7
0.75 to 0.99	1,186	1.7	10	0.4	13	1.4	18	0.6	606	1.2	233	31.9	306	2.2
1.00 to 1.24	6,548	9.2	68	2.7	45	4.8	55	1.8	4,774	9.5	157	21.5	1,449	10.3
1.25 to 1.49	13,238	18.6	193	7.6	114	12.2	216	7.3	8,463	16.9	11	1.5	4,241	30.2
1.50 to 1.74	17,309	24.3	333	13.1	218	23.4	334	11.2	11,523	23.1	3	0.4	4,898	34.9
1.75 to 1.99	10,747	15.1	279	11.0	331	35.5	383	12.9	8,500	17.0	1	0.1	1,253	8.9
2.00 to 2.24	9,050	12.7	853	33.6	111	11.9	572	19.2	6,416	12.8			1,098	7.8
2.25 to 2.49	2,914	4.1	274	10.8	33	3.5	395	13.3	1,976	4.0			236	1.7
2.50 to 2.74	2,813	4.0	295	11.6	43	4.6	369	12.4	1,886	3.8			220	1.6
2.75 to 2.99	2,136	3.0	89	3.5	11	1.2	273	9.2	1,723	3.4			40	0.3
3.00 to 3.24	2,715	3.8	106	4.2	6	0.7	238	8.0	2,233	4.5			132	0.9
3.25 to 3.49	790	1.1	15	0.6	3	0.3	60	2.0	701	1.4			11	0.1
3.50 to 3.74	695	1.0	9	0.3			39	1.3	632	1.3			15	0.1
3.75 to 3.99	54	0.1	5	0.2			4	0.1	43	0.1			2	(2)
4.00 to 4.24	284	0.4	4	0.1	1	0.1	16	0.5	234	0.5			29	0.2
4.25 and over	149	0.2	2	0.1			2	0.1	135	0.3			10	0.1

[1] Includes 5,983 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.

[2] Less than one-tenth of 1 per cent.

The 71,156 wage-earners shown above as employed in stone quarries constituted almost one-eighth (12.2 per cent) of the total number reported in 1902 by all the mines and quarries of the United States. The rates of pay were somewhat lower for stone quarries than for all minerals combined, the range of wages for the bulk (79.9 per cent) of those employed in stone quarries having been from $1 to $2.24, while of the total for all minerals 80.8 per cent received between $1 and $2.74 per day. The difference in wages is more clearly shown, perhaps, in the following comparison: When the figures for all minerals are combined it is found that 57.2 per cent of the total number were paid $2 per day or over, while 42.8 per cent were paid less than $2. In stone quarries, on the other hand, only 30.4 per cent of the wage-earners received $2 per day or over, 69.6 per cent of them having been paid less than $2.

Of the 71,156 wage-earners 49,945 (about seven-tenths) were returned as quarrymen and stonecutters. The greatest concentration of these wage-earners was between rates $1 and $2.24, 79.3 per cent of the total number being included. The next four groups, including those who received from $2.25 to $3.24 per day, constituted 15.7 per cent of the total number. Thus it is seen that 95 per cent of the quarrymen and stonecutters were paid between $1 and $3.24 per day.

The total number of engineers employed in stone quarries in 1902 was 2,540, the range of wages for 80.1 per cent of them being from $1.50 to $2.74 per day. There were 933 firemen reported, 83 per cent of whom received between $1.25 and $2.24 per day. About one-third of all the engineers are included in the single rate group, $2 to $2.24, while 35.5 per cent of the firemen are included in the group, $1.75 to $1.99. There is less concentration in the figures for machinists and other mechanics, the range of wages for 2,780 of them—93.4 per cent of the total number—being from $1.25 to $3.24 per day.

The number of boys under 16 years employed in stone quarries was 731, only 1 per cent of the total number of wage-earners. Of these boys, 69 were paid less than 50 cents a day and 647 were paid between 50 cents and $1.24.

Under the head of "all other wage-earners" are included 14,031 employees, more than three-fourths of whom received from $1 to $1.74 per day and 16.7 per cent received from $1.75 to $2.24.

Supplies, materials, and miscellaneous expenses.—As shown in Table 37, the total amount expended for supplies and materials was $10,739,736. Of this amount, $5,403,912, or 50.3 per cent, was expended in quarrying limestones and dolomites; $2,493,065, or 23.2 per cent, in quarrying siliceous crystalline rocks; $1,298,190, or 12.1 per cent, in quarrying sandstones and quartzites; $825,822, or 7.7 per cent, at marble quarries; $680,361, or 6.3 per cent, at slate quarries; and $38,386, or four-tenths of 1 per cent, in connection with the production of silica sand.

Miscellaneous expenses amounted to $3,976,865, of which total $1,156,754, or 29.1 per cent, was paid for royalties and rent of quarrying plants, and $2,820,111, or 70.9 per cent, for rent of offices, taxes, and other sundries.

Mechanical power.—The total primary power reported aggregated 178,878 horsepower, of which 167,744, or 93.8 per cent, was applied through 4,265 steam engines, and 1,378, or seven-tenths of 1 per cent, through 92 gas or gasoline engines. Fifty-six water wheels furnished 6,731 horsepower, or 3.8 per cent; under "other power," 2,114 horsepower, or 1.2 per cent, was reported; and 911 horsepower, or five-tenths of 1 per cent, was rented from other establishments.

There were, in addition, 97 electric motors owned by the operators reporting them, having a total horsepower of 3,521. Of these, 35 with a horsepower of 769 were used in the production of limestones and dolomites; 32 with 2,220 horsepower, in the production of marble; and 23 with 442 horsepower, in the production of siliceous crystalline rocks.

Production.—The value of the annual production of all classes of stone from 1890 to 1902 is shown in the following table:

TABLE 6.—*Value of annual production of stone: 1890 to 1902.*[1]

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Value of product.	YEAR.	Value of product.
1890	$53,035,620	1897	$36,070,651
1891	47,294,746	1898	38,441,354
1892	48,721,625	1899	44,090,670
1893	33,965,573	1900	48,008,739
1894	37,065,030	1901	60,275,702
1895	34,688,816	1902	[2]69,830,351
1896	31,346,171		

The values increased and decreased alternately from 1891 to the close of 1895, and there was a further decrease in 1896, when the lowest value was reported. Since 1896 there has been a steady increase. These fluctuations of value were distributed through all classes of stone.

Discussing the period covered by this table, a decline in the production of granite, limestone, and sandstone began in 1891. The production of slate declined in 1893, but increased a little in 1894. The production of marble fell off in 1893. The return to more prosperous conditions began in 1897, and by 1902 the earlier output had been equaled or exceeded for all classes of stone but sandstones and quartzites, the value of which for 1902 was still below its value for 1890.

Table 37 presents detailed statistics of all classes of stone for 1902.

CLASSIFICATION AND OCCURRENCE.

The matter of the classification of such rocks as are here considered has from the very beginning been one of difficulty, and one which has not yet been solved in a thoroughly satisfactory manner. As a compromise between the minute subdivisions desired by the scientists and the extremely general and often erroneous classification of the quarrymen, the following division has been adopted, which is essentially that followed in 1880:

1. *Limestones and dolomites.*—These are all sedimentary and bedded rocks, composed essentially of lime carbonate, or the mixed carbonates of lime and magnesia. Such have been found to pass into each other by insensible gradations, certain quarries in the states of the Mississippi valley producing at the same time material which, if classed on purely chemical grounds, would be relegated to both divisions. Obviously a too close adherence to scientific principles would lead to confusion, and hence all are here grouped together.

2. *Marble.*—Here are included stones identical in composition with those noted under limestones and dolomites, but which through changes, mainly physical, have come to possess properties rendering them desirable for high-grade building or ornamental work. As with the last, they are variable in composition. The marbles of the Rutland, Vt., area, for instance, are largely limestone, while those of the Berkshire county, Mass., area are largely dolomite. With the marbles are also included a small series of serpentinous rocks, which are likewise utilized for decorative purposes.

3. *Sandstones and quartzites.*—The rocks here brought together are composed essentially of consolidated sands. They are made over, as it were, from the detritus of preexisting rocks. Those classed as "quartzites" are sandstones which have been rendered more or less crystalline through the deposition of silica between the original sand particles, as is the case with the "jasper" of Sioux Falls, S. Dak., or the Potsdam sandstone of St. Lawrence county, N. Y. The tuffs and other volcanic fragmental rocks are also here included.

4. *Silica sand.*—This is crushed sandstone, used in the manufacture of glass and for other purposes.

5. *Siliceous crystalline rocks.*—Here are included the true granites and syenites, together with the trappean rocks, such as are often designated as black granites; the gneisses, or so-called striped or bastard granites; the mica schists; and melaphyre, basalt, andesite, and other volcanic rocks.

6. *Slate.*—This is an argillaceous rock, which, through compression and shearing, has been more or less metamorphosed and rendered fissile, by virtue of which property it may be split into sheets suitable for roofing and other purposes.

Occurrence.—In this connection the following statement relative to the possible resources of the various states of the Union and their present development is not without interest. The list shows the rocks which are known to occur in each state in quantities sufficient for quarrying. The names in small capitals indicate those which were actually quarried during 1902.

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[1] Exclusive of glass sand, which was not reported by the Geological Survey during the years here shown except in 1902, when it was not included with stone.

[2] Exclusive of limestone, valued at $210,798, used in the manufacture of cement.

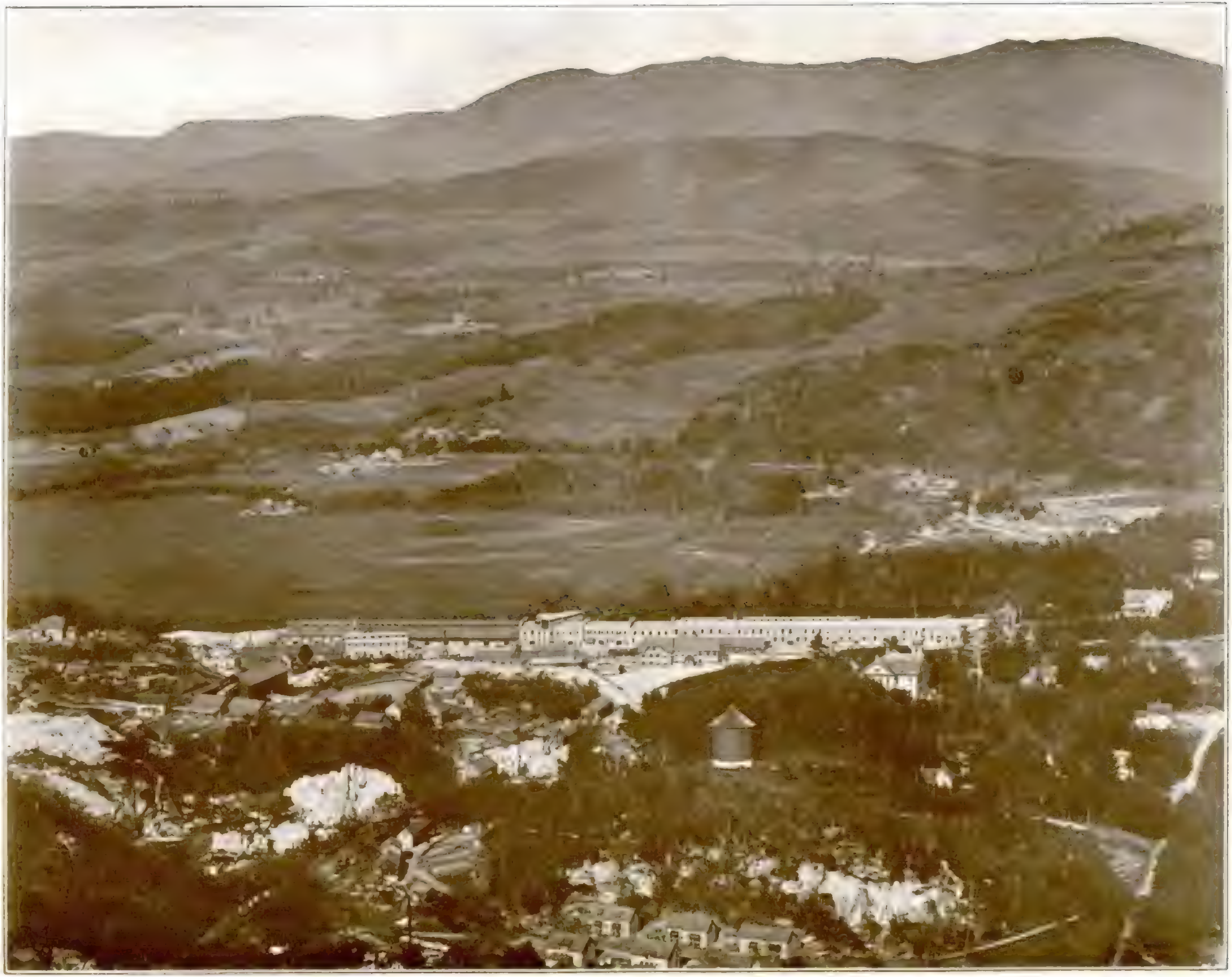

PLATE II.—GENERAL VIEW OF STONE YARDS AND WORKS OF THE VERMONT MARBLE COMPANY, PROCTOR, VERMONT.

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STATE OR TERRITORY.	Present and prospective resources.
Alabama	Granite, LIMESTONE, MARBLE, SANDSTONE, slate.
Arizona	Dolomite, GRANITE, ONYX marble, SANDSTONE, trappean rocks, volcanic rocks, and tuffs.
Arkansas	ELÆOLITE SYENITE, GRANITE, LIMESTONE, marble, SANDSTONE, SLATE.
California	GRANITE, LIMESTONE, MARBLE, SANDSTONE, SLATE, TRAPPEAN ROCKS, VERD ANTIQUE MARBLE, VOLCANIC ROCKS, and TUFFS.
Colorado	GRANITE, LIMESTONE, marble, QUARTZITE, SANDSTONE, TRAPPEAN ROCKS, VOLCANIC ROCKS, and TUFFS.
Connecticut	DIABASE, GNEISS, GRANITE, LIMESTONE, MARBLE, SANDSTONE, verd antique marble.
Delaware	GABBRO, GNEISS, limestone, quartzite, serpentine.
Florida	LIMESTONE (shell and oolitic).
Georgia	GNEISS, GRANITE, LIMESTONE, MARBLE, SANDSTONE, SLATE, VERD ANTIQUE MARBLE.
Idaho	Dolomite, GRANITE, LIMESTONE, marble, SANDSTONE, TRAPPEAN ROCKS, volcanic rocks, and tuffs.
Illinois	DOLOMITE, LIMESTONE, SANDSTONE.
Indian Territory	Dolomite, GRANITE, LIMESTONE, sandstone.
Indiana	DOLOMITE, LIMESTONE, SANDSTONE.
Iowa	DOLOMITE, LIMESTONE, SANDSTONE.
Kansas	DOLOMITE, LIMESTONE, SANDSTONE.
Kentucky	DOLOMITE, LIMESTONE, SANDSTONE.
Louisiana	Limestone, sandstone.
Maine	GNEISS, GRANITE, LIMESTONE, sandstone, SLATE, TRAPPEAN ROCKS, verd antique marble.
Maryland	GNEISS, GRANITE, LIMESTONE, MARBLE, SANDSTONE, SLATE, verd antique marble.
Massachusetts	GNEISS, GRANITE, LIMESTONE, MARBLE, SANDSTONE, slate, TRAPPEAN ROCKS, VERD ANTIQUE MARBLE.
Michigan	DOLOMITE, gneiss, GRANITE, LIMESTONE, SANDSTONE, slate.
Minnesota	DOLOMITE, gneiss, GRANITE, LIMESTONE, quartzite, SANDSTONE, slate.
Mississippi	Limestone, sandstone.
Missouri	DIABASE, DOLOMITE, GRANITE, LIMESTONE, SANDSTONE.
Montana	DOLOMITE, gneiss, GRANITE, LIMESTONE, MARBLE, SANDSTONE, trappean rocks, volcanic rocks, and tuffs.
Nebraska	DOLOMITE, LIMESTONE, SANDSTONE.
Nevada	Dolomite, granite, limestone, marble, SANDSTONE, slate, trappean rocks, VOLCANIC ROCKS, and tuffs.
New Hampshire	GNEISS, GRANITE, limestone, slate.
New Jersey	DIABASE, DOLOMITE, GNEISS, GRANITE, LIMESTONE, marble, SANDSTONE, SLATE.
New Mexico	Granite, limestone, MARBLE, SANDSTONE, trappean rocks, verd antique marble, volcanic rocks, and tuffs.
New York	DOLOMITE, GNEISS, GRANITE, LIMESTONE, MARBLE, NORITE, SANDSTONE, SLATE, TRAPPEAN ROCKS, verd antique marble.
North Carolina	Dolomite, GNEISS, GRANITE, LIMESTONE, marble, SANDSTONE, serpentine, slate, trappean rocks.
North Dakota	Dolomite, limestone, sandstone.
Ohio	DOLOMITE, LIMESTONE, SANDSTONE.
Oklahoma	DOLOMITE, LIMESTONE, SANDSTONE.
Oregon	DOLOMITE, GRANITE, LIMESTONE, SANDSTONE, trappean rocks, volcanic rocks, and tuffs.
Pennsylvania	DIABASE, DOLOMITE, GNEISS, GRANITE, LIMESTONE, MARBLE, SANDSTONE, SLATE, SERPENTINE.
Rhode Island	Dolomite, GNEISS, GRANITE, limestone.
South Carolina	Gneiss, GRANITE, limestone.
South Dakota	LIMESTONE, QUARTZITE, SANDSTONE.
Tennessee	Granite, LIMESTONE, MARBLE, SANDSTONE, slate.
Texas	GRANITE, LIMESTONE, marble, SANDSTONE, slate, trappean rocks, volcanic rocks and tuffs.
Utah	GRANITE, LIMESTONE, MARBLE, ONYX MARBLE, SANDSTONE, trappean rocks, volcanic rocks, and tuffs.
Vermont	DOLOMITE, gneiss, GRANITE, LIMESTONE, MARBLE, SLATE, verd antique marble.
Virginia	Diabase, DOLOMITE, gneiss, GRANITE, LIMESTONE, marble, SANDSTONE, SLATE.
Washington	GRANITE, LIMESTONE, MARBLE, SANDSTONE, trappean rocks, VERD ANTIQUE MARBLE, volcanic rocks, and tuffs.
West Virginia	Calcareous tufa, LIMESTONE, SANDSTONE, travertine.
Wisconsin	DOLOMITE, gneiss, GRANITE, LIMESTONE, SANDSTONE.
Wyoming	Granite, LIMESTONE, marble, SANDSTONE, trappean rocks, volcanic rocks, and tuffs.

A critical examination of the foregoing statement shows that the siliceous crystalline rocks, marbles, and slates are limited in their distribution mainly to the areas east of the Appalachians, those bordering along the Great Lakes, and those west of the front range of the Rocky mountains. The sandstones and limestones, on the other hand, are more widely distributed, although found best developed for quarry purposes in the great interior regions of the Mississippi valley. These points will be brought out in greater detail in the discussion of the various classes of stone.

The importance of a study of the stone resources of the various states is being gradually recognized, and reports covering the subject with more or less completeness were issued by Ohio and Minnesota in 1884, New York in 1888, Arkansas in 1890, Indiana and Pennsylvania in 1896, Maryland and Wisconsin in 1898, and Georgia in 1902.

LIMESTONES AND DOLOMITES.

The rocks brought together here differ from those included under the head of marble not so much in composition as in physical properties. They represent the limestones and dolomites of the ordinary unmetamorphosed type, such as are lacking in qualities rendering them susceptible for a high grade of ornamental work, but suitable, it may be, for building. As will be noted, a large proportion of the material quarried under this name was utilized for other than structural purposes.

Table 7 presents comparative statistics for this industry for 1902 and 1889.

TABLE 7.—*Comparative summary: 1902 and 1889.*

	1902	1889
Number of quarries	3,246	1,954
Number of operators	3,137	(1)
Salaried officials, clerks, etc.:		
Number	2,231	[2]433
Salaries	$1,843,747	(3)
Wage-earners:		
Average number	31,547	[2]30,241
Wages	$14,750,638	[3]$10,121,985
Contract work	$36,381	(1)
Miscellaneous expenses	$1,440,081	$743,483
Cost of supplies and materials	$5,466,912	$1,227,246
Value of product	[4]$30,441,801	$19,095,179

[1] Not reported.
[2] Foremen included as wage-earners.
[3] Salaries included in wages.
[4] The report of the United States Geological Survey does not include limestone, valued at $210,798, consumed in the manufacture of cement.

Statistics for 1880 are not suitable for comparison, since the census returns for that year excluded all material not used for building purposes and did not differentiate between limestones and marbles. (See Table 12.)

The number of quarries has increased by 1,292, or 66.1 per cent, since 1889, the amount paid in salaries and wages has increased $6,472,400, or 63.9 per cent, and the value of products $11,346,622, or 59.4 per cent. Of the 3,137 operators reported for 1902, 2,282 were individuals, 480 firms, 344 incorporated companies, and 31 cooperative associations and other forms of organization.

In 1902 development work was reported at 3 quarries—2 in California and 1 in Wisconsin. Four salaried officials, clerks, etc., received $2,800, and there were 33 wage-earners to whom $10,430 was paid in wages. Miscellaneous expenses were $1,075, and supplies and materials cost $5,250.

Employees and wages.—In 1902 the 31,547 wage-earners formed 93.4 per cent of the total number of employees and the $14,750,638 paid them as wages was 88.9 per cent of the total amount expended in salaries and wages. In addition, $36,381 was paid for contract work, which gave employment to 137 persons.

The following table presents the average number of wage-earners employed during each month:

TABLE 8.—*Average number of wage-earners employed during each month: 1902.*

MONTH	Wage-earners.
January	22,581
February	22,410
March	27,638
April	33,077
May	35,084
June	35,988
July	36,447
August	36,965
September	36,621
October	34,917
November	30,601
December	26,231

The greatest number of wage-earners, 36,965, was reported for August, and the least, 22,410, for February; thus the variation was 14,555, or 46.1 per cent of the yearly average number, 31,547. This yearly average is 44.3 per cent of the total for all classes of stone.

The following table shows the number of wage-earners at certain specified daily rates of pay by occupations and also the percentages which these numbers form of the total number in the class:

TABLE 9.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number	Per cent of total.	Average number.	Per cent of total.	Average number	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1]31,547	100.0	940	100.0	358	100.0	935	100.0	22,086	100.0	258	100.0	7,020	100.0
Less than 0.50	16	0.1									16	6.2		
0.50 to 0.74	196	0.6			1	0.3			35	0.2	95	36.8	65	0.9
0.75 to 0.99	389	1.2			1	0.3	2	0.2	215	1.0	84	32.6	87	1.2
1.00 to 1.24	4,126	13.1	17	1.8	13	3.6	25	2.7	3,106	14.1	60	23.2	905	12.9
1.25 to 1.49	7,870	24.9	57	6.1	68	19.0	77	8.2	5,450	24.7	3	1.2	2,215	31.6
1.50 to 1.74	9,195	29.1	166	17.7	130	36.3	159	17.0	6,232	28.2			2,508	35.7
1.75 to 1.99	4,944	15.7	113	12.0	83	23.2	110	11.8	4,011	18.2			627	8.9
2.00 to 2.24	2,637	8.4	288	30.6	35	9.8	207	22.1	1,631	7.4			476	6.8
2.25 to 2.49	885	2.8	119	12.7	10	2.8	147	15.7	578	2.6			31	0.5
2.50 to 2.74	580	1.8	101	10.7	12	3.3	96	10.3	317	1.4			54	0.8
2.75 to 2.99	193	0.6	45	4.8	4	1.1	72	7.7	66	0.3			6	0.1
3.00 to 3.24	218	0.7	25	2.7	1	0.3	24	2.6	144	0.6			24	0.3
3.25 to 3.49	114	0.4	4	0.4			3	0.3	105	0.5			2	(2)
3.50 to 3.74	121	0.4	2	0.2			9	1.0	106	0.5			4	0.1
3.75 to 3.99	1	(2)											1	(2)
4.00 to 4.24	58	0.2	1	0.1			3	0.3	39	0.2			15	0.2
4.25 and over	4	(2)	2	0.2			1	0.1	1	(2)				

[1] Includes 3,772 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.
[2] Less than one tenth of 1 per cent.

As shown by the above table, 28,772 wage-earners, 91.2 per cent of the total number, received between $1 and $2.24 per day. Of the quarrymen and stonecutters, 20,430, or 92.7 per cent, are included between the same rates. There is little need for highly skilled workmen in limestone quarries, and consequently the rates paid are practically the same as those paid in all trades for unskilled labor.

The rates paid to engineers and to machinists and other mechanics were somewhat higher than those for other wage-earners; 83.7 per cent of the engineers received from $1.50 to $2.74 per day, and 76.9 per cent of the machinists and other mechanics were included between the same rates. The range of wages for over three-fourths (78.5 per cent) of the firemen reported was between $1.25 and $1.99 per day.

In all, only 258 boys under 16 years were reported, which number is less than 1 per cent of the total number of wage-earners. Of these boys, 16 were paid less than 50 cents a day, and 239 were paid from 50 cents to $1.24. The boys reported were not employed in any one locality. There were 51 in Indiana, 36 in Virginia, and 33 in Pennsylvania. The others were distributed in small groups through a large number of states.

Under "all other wage-earners" are included 7,020 men, 22.3 per cent of the total number. The rates paid to these employees differ very little from those for quarrymen and stonecutters. About four-fifths (5,628, or 80.2 per cent) of those classed as "all other wage-earners" received between $1 and $1.74 per day, and 1,103, or 15.7 per cent, received from $1.75 to $2.24.

Supplies, materials, and miscellaneous expenses.—Supplies and materials, of which a large amount was fuel for lime burning, cost $5,403,912. The amount paid for royalties and rent of quarrying plants was $422,693, or 29.4 per cent of the total miscellaneous expenses; $1,017,388, or 70.6 per cent, was paid for rent of offices, taxes, insurance, and other sundries.

Mechanical power.—The total primary power reported aggregated 64,500 horsepower, of which 61,547, or 95.4 per cent, was applied through 1,703 steam engines; 1,031, or 1.6 per cent, through 59 gas or gasoline engines; and 502, or eight-tenths of 1 per cent, by 15 water wheels. Under "other power" 1,221 horsepower, or 1.9 per cent, was reported. There were in addition 35 electric motors with an aggregate horsepower of 769. Rented horsepower aggregated 199, or three-tenths of 1 per cent.

Production.—The following table shows the annual value of the production of limestones and dolomites from 1890 to 1902:

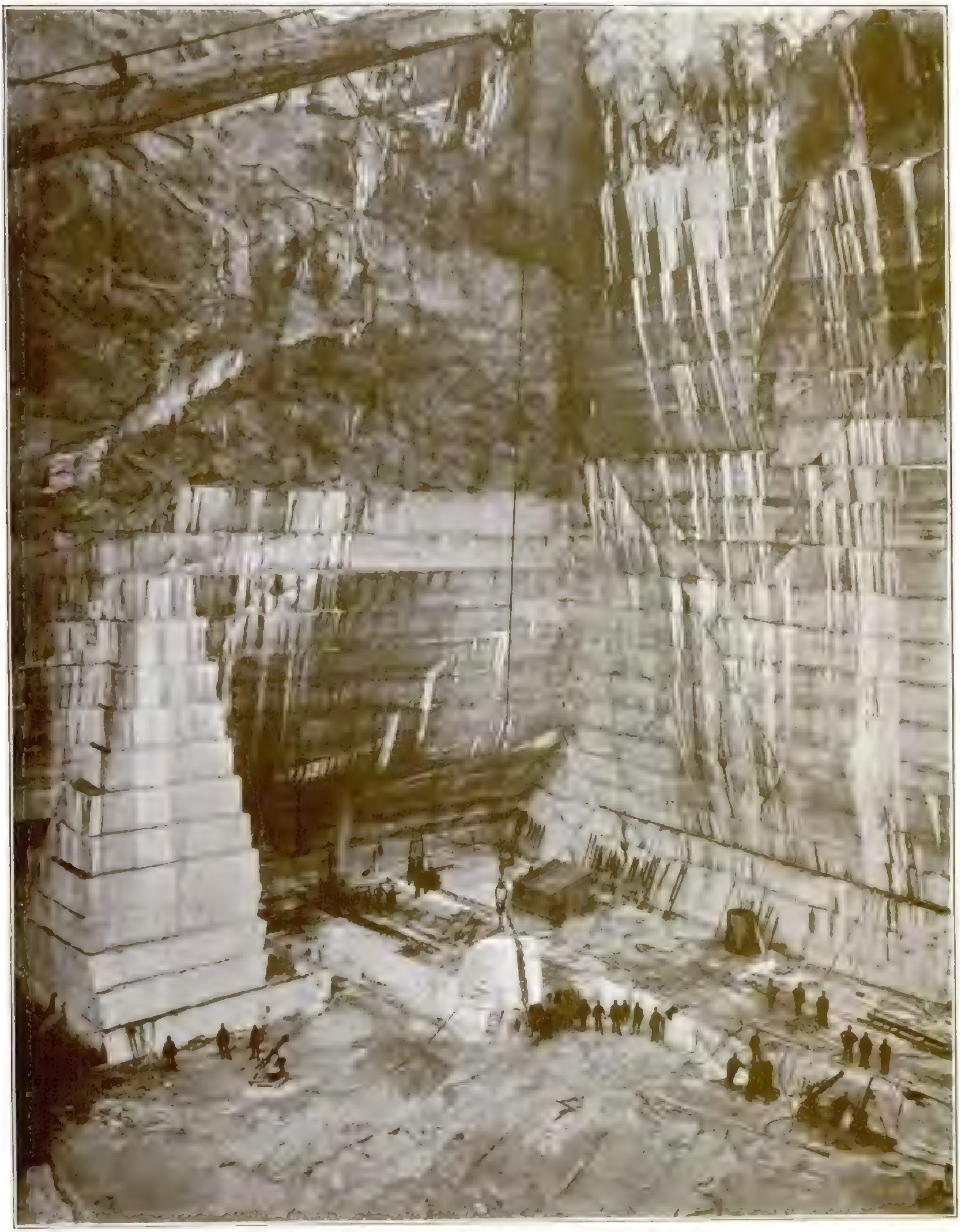

PLATE III.—INTERIOR VIEW OF MARBLE QUARRY, PROCTOR, VERMONT

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TABLE 10.—*Value of annual production of limestones and dolomites: 1890 to 1902.*

[United States Geological Survey "Mineral Resources of the United States."]

YEAR	Total.	YEAR	Total.
1890	$19,095,179	1897	$14,822,661
1891	15,792,000	1898	16,080,056
1892	18,342,000	1899	18,757,963
1893	13,947,223	1900	20,354,019
1894	16,512,904	1901	26,406,897
1895	15,308,755	1902	30,441,801
1896	13,022,637		

There was a decrease in value of product from 1890 to 1891, an increase in 1892, a decrease again in 1893, with an advance in 1894 and a slight falling off in 1895. In 1896 the retrograde movement in value reached its lowest point. The increase since then has been constant.

The following table shows the value of the annual production of limestones and dolomites, classified by uses, 1894 to 1902:

TABLE 11.—*Limestones and dolomites, classified by uses: 1894 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	VALUE OF PRODUCT			
	Building	Made into lime.	Blast furnace flux.	All other uses.
1894	$7,382,055	$8,610,607	$520,242	(1)
1895	7,350,248	6,588,822	1,369,685	(1)
1896	5,491,227	6,327,900	1,203,510	(1)
1897	7,029,295	6,390,487	1,402,879	(1)
1898	4,154,158	6,886,749	1,874,899	$3,164,250
1899	5,075,158	6,993,067	2,570,799	4,118,939
1900	4,329,706	6,797,496	3,687,394	5,539,423
1901	5,219,310	8,204,054	4,659,836	8,323,697
1902	5,563,084	9,335,618	5,271,252	10,271,847

[1] Not reported.

The total value of the output for 1902 was $30,441,801, of which only $5,563,084 was utilized for building purposes, the remainder being used for flagging, curbing, lime burning, roadmaking, rubble, riprap, flux, etc. The largest single item, which amounted to $9,335,618, was for lime burning, and the second, that of $5,271,252, was for flux in metallurgical operations. A large amount was also used for macadam, not so much on account of its suitability as because of its cheapness, the almost complete absence of siliceous, and especially trappean, rocks from the Mississippi valley states necessarily limiting the selection to either limestone or sandstone.

The detailed statistics of this industry for 1902 are shown in Table 38.

Occurrence.—Rocks of this type, though occurring in every state of the Union, are found in their maximum development in the states of the Mississippi valley, where the agents of metamorphism have exercised but little influence and the rocks have retained their original sedimentary character. In some instances rocks of this class are of a highly fossiliferous nature. Such, however, are not as a rule utilized for building purposes, but rather for lime burning, etc. Those utilized for architectural purposes are principally of the fine grained homogeneous type, such as the dolomitic limestones of Lemont, Ill., or of the oolitic type, such as the stones so extensively developed in the region of Bedford, Ind. These stones work readily under the tool, and when free from injurious constituents are admirably adapted for elaborate structures where much carved work is required. This is especially true of the stone at Bedford, where the conditions are particularly favorable for quarrying, the beds having retained very nearly their original horizontality. The quarry development is extensive, as is evident from the illustration given in Plate I. The ease with which these stones are removed by the aid of machinery from the quarry bed, and the readiness with which they may be worked, as well as their satisfactory colors, have rendered them general favorites for building purposes and they have found their way into the larger cities all over the country.

MARBLE.

The stones here included under the head of marble are mainly those composed of carbonate of lime, or the mixed carbonates of lime and magnesia, in other words, limestones and dolomites, which, owing to their color and physical properties, are suitable for high-grade building and ornamental purposes.

It should be stated that no sharp line can be drawn between what is popularly known as marble and the common limestones and dolomites, as what is or what is not suitable for decoration must depend largely upon the taste of the individual. The stones here included are, however, those which are sold as marble, and in two instances serpentinous rock—the so-called verd antique marble.

The following table is a comparative summary of the marble industry from 1870 to 1902.

TABLE 12.—*Comparative summary: 1902, 1889, 1880, and 1870.*

	1902	1889	1880[1]	1870
Number of quarries	83	103	616[3]	(2)
Number of operators	75	71	(2)	[3]22
Salaried officials, clerks, etc.:				
Number	352	[4]96	(2)	(2)
Salaries	$341,921	(5)	(2)	(2)
Wage-earners.				
Average number	4,070	[6]4,438	[6]15,046[4]	795
Wages	$2,212,610	[5]$1,809,211	(2)	$142,270
Miscellaneous expenses	$982,877	$210,272	(2)	(2)
Cost of supplies and materials	$825,822	$655,586	[7]$61,408	$28,916
Value of product	$5,044,182	$3,488,170	$6,856,081	$801,300

[1] Includes limestones and dolomites, statistics for marble can not be separated.
[2] Not reported.
[3] Establishments.
[4] Foremen included as wage-earners.
[5] Salaries included in wages.
[6] Greatest number employed.
[7] Value of explosives.

In the published statistics of the census of 1880 no discrimination was made between the two classes of rocks. The writer, knowing the character of the output of the various quarries, estimated the value produced that year at $2,044,225 which, it will be observed by reference to Table 12, was increased to $3,488,170 in 1889 and to $5,044,182 in 1902.

There were 83 quarries in operation during 1902 with 352 salaried officials, clerks, etc., and 4,070 wage-earners, while in 1889 there were 103 quarries with 254 salaried officials, clerks, etc., and 4,275 wage-earners. The decrease in the number of active quarries is very probably due to the consolidation and incorporation of companies. The apparent decrease in the number of wage-earners may be accounted for by the different methods pursued by the several censuses in obtaining the average number employed: also by the introduction of machinery and improved methods in quarrying. That this decrease is only apparent, seems all the more probable when it is taken into consideration that both the amount paid as wages and the value of the marble produced increased to a marked degree during each census year.

There were 10 quarries reported as being developed by as many operators, 8 of whom were incorporated companies and had issued capital stock and bonds to the amount of $5,031,500. Six of these quarries were located in Washington, and there was 1 each in California, Kentucky, Montana, and Utah. These gave employment to 7 salaried officials and 25 wage-earners, who received $22,405 in salaries and wages. From these 10 quarries supplies and materials to the amount of $5,218, and miscellaneous expenses to the amount of $2,550, was reported.

There were 114 quarries reported idle during 1902 and these were controlled by 114 operators, 53 of whom were incorporated companies. Capital stock and bonds were issued to the amount of $9,127,250 by 25 of these companies.

Capital stock of incorporated companies.—Of the 75 operators of productive quarries, 45 were incorporated companies. Forty-three of these made returns showing a capital stock of $17,609,900 and a bonded indebtedness of $2,708,500. The details are shown in the following table:

TABLE 13.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	California.	Georgia.	Massachusetts.	New York.	Pennsylvania.	Tennessee.	Vermont.	Washington.	All other states and territories.[1]
Number of incorporated companies	45	2	5	3	7	2	8	9	5	4
Number reporting capitalization	43	2	4	3	6	2	8	9	5	4
Capital stock and bonds issued	$20,318,400	$887,000	$4,200,000	$398,100	$745,000	$275,800	$1,175,000	$9,113,500	$3,504,000	$220,000
Capital stock:										
Total authorized—										
Number of shares	1,556,650	210,000	54,000	6,500	7,100	6,500	8,650	81,700	1,180,500	1,700
Par value	$20,414,000	$750,000	$5,400,000	$450,000	$710,000	$325,000	$865,000	$7,970,000	$3,684,000	$260,000
Total issued—										
Number of shares	1,448,348	147,000	33,000	5,262	6,940	1,016	8,250	79,280	1,163,300	1,300
Par value	$17,609,900	$887,000	$3,300,000	$376,100	$694,000	$200,800	$825,000	$7,803,000	$3,504,000	$220,000
Dividends paid	$239,250				$11,250		$6,000	$222,000		
Common—										
Authorized—										
Number of shares	1,519,950	210,000	37,500	6,500	7,100	6,500	8,650	61,500	1,180,500	1,700
Par value	$16,744,000	$750,000	$3,750,000	$450,000	$710,000	$325,000	$865,000	$5,950,000	$3,684,000	$260,000
Issued—										
Number of shares	1,413,768	147,000	18,500	5,262	6,940	1,016	8,250	59,200	1,163,300	1,300
Par value	$14,151,900	$887,000	$1,850,000	$376,100	$694,000	$200,800	$825,000	$5,795,000	$3,504,000	$220,000
Dividends paid	$139,250				$11,250		$6,000	$122,000		
Preferred—										
Authorized—										
Number of shares	36,700		16,500					20,200		
Par value	$3,670,000		$1,650,000					$2,020,000		
Issued—										
Number of shares	34,580		14,500					20,080		
Par value	$3,458,000		$1,450,000					$2,008,000		
Dividends paid	$100,000							$100,000		
Bonds:										
Authorized—										
Number	8,758		1,180	50	650	75	350	6,453		
Par value	$4,475,000		$900,000	$25,000	$110,000	$75,000	$350,000	$3,015,000		
Issued—										
Number	4,841		1,180	11	510	75	350	2,715		
Par value	$2,708,500		$900,000	$22,000	$51,000	$75,000	$350,000	$1,310,500		
Interest paid	$93,290		$30,000	$1,320		$6,000	$21,000	$34,970		
Assessments levied	$15,000		$15,000							

[1] Includes incorporated companies distributed as follows: Alabama, 1, Maryland, 2, New Mexico, 1.

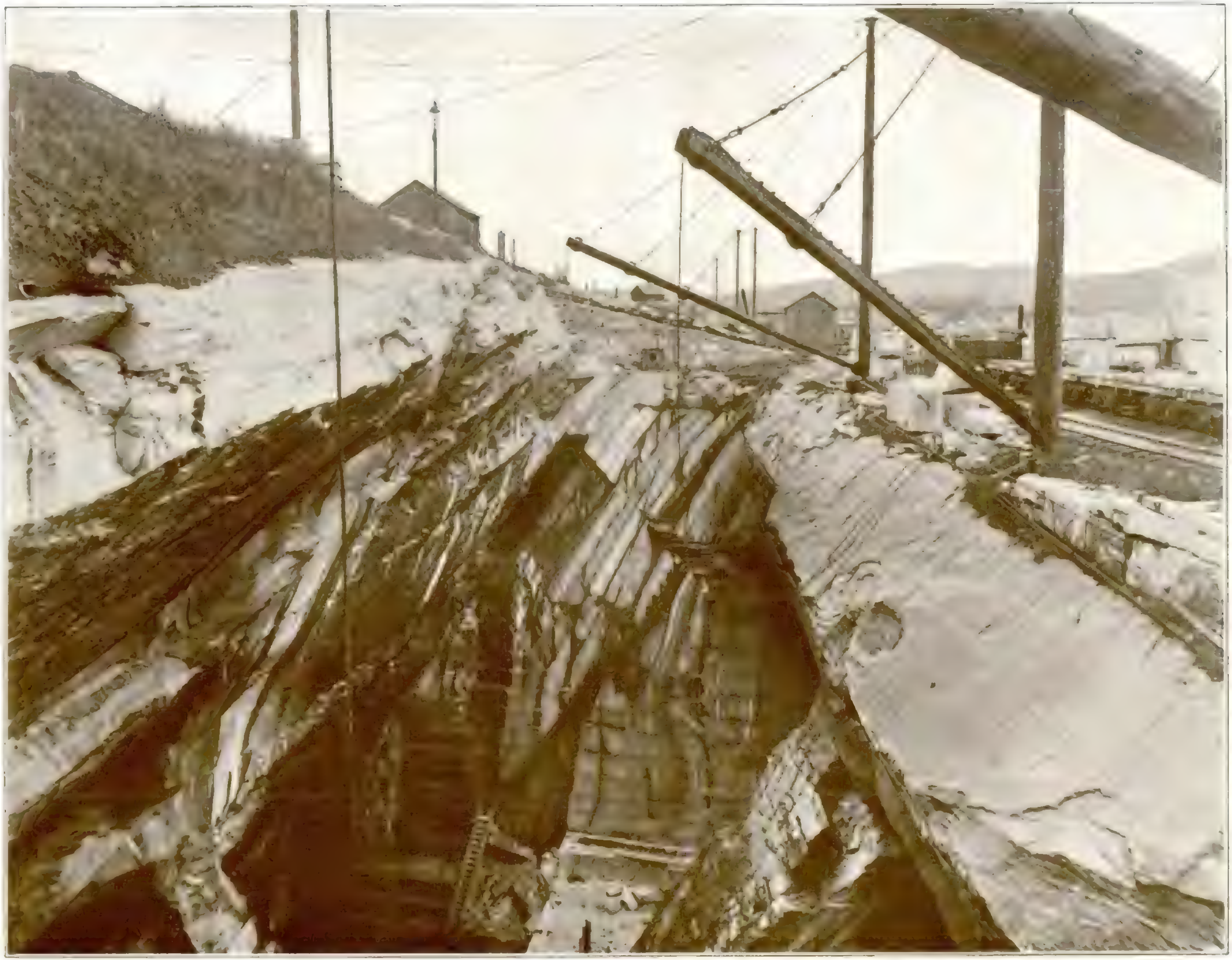

PLATE IV.—INTERIOR VIEW OF MARBLE QUARRY, RUTLAND, VERMONT.

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The value of the capital stock and bonds issued by the Vermont companies constitutes 44.9 per cent of the total; by the Georgia companies, 20.7 per cent; by the Washington companies, 17.2 per cent; and by the Tennessee companies, 5.8 per cent. The par value of the capital stock issued was 86.3 per cent of the total authorized. The dividends paid amounted to 3.8 per cent of the total stock on which they were declared.

The production of the mines operated by the 45 incorporated companies, including the 2 not reporting details of capitalization, was valued at $4,469,791, or 88.6 per cent of the total value.

Employees and wages.—The 4,070 wage-earners constituted 92 per cent of the salaried employees and wage-earners, and their wages were 86.6 per cent of the total salaries and wages. Vermont led with 51 per cent of the wage-earners; Tennessee was second, with 14.9 per cent; New York was third, 11.5 per cent; and Georgia was fourth, with 7.6 per cent.

The following table shows the average number of wage-earners employed each month:

TABLE 14.—*Average number of wage-earners employed during each month: 1902.*

MONTH	Wage-earners.
January	3,574
February	3,618
March	3,880
April	4,090
May	4,316
June	4,184
July	4,186
August	4,228
September	4,430
October	4,275
November	4,119
December	3,940

September was the month during which the largest number of wage-earners, 4,430, was employed, although the variation during the year was not great. The smallest number, 3,574, was employed in January.

The following table shows the distribution of wage-earners according to daily rates of pay, by occupations:

TABLE 15.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1] 4,070	100.0	113	100.0	80	100.0	324	100.0	2,513	100.0	22	100.0	1,018	100.0
Less than 0.50	6	0.1									6	27.3		
0.50 to 0.74	17	0.4	1	0.9					1	[2]	14	63.6	1	0.1
0.75 to 0.99	61	1.5			4	5.0	1	0.3	12	0.5			44	4.3
1.00 to 1.24	558	13.7	8	7.1	20	25.0	2	0.6	468	18.6			60	5.9
1.25 to 1.49	963	23.7	25	22.1	4	5.0	88	27.2	585	23.3			261	25.6
1.50 to 1.74	858	21.1	12	10.6	13	16.2	50	15.4	438	17.4	2	9.1	343	33.7
1.75 to 1.99	286	7.0	7	6.2	19	23.8	22	6.8	146	5.8			92	9.0
2.00 to 2.24	293	7.2	30	26.5	11	13.8	34	10.5	150	6.0			68	6.7
2.25 to 2.49	182	4.5	6	5.3	5	6.2	78	24.1	35	1.4			58	5.7
2.50 to 2.74	294	7.2	15	13.3			23	7.1	199	7.9			57	5.6
2.75 to 2.99	159	3.9	1	0.9	1	1.2	2	0.6	141	5.6			14	1.4
3.00 to 3.24	130	3.2	6	5.3	3	3.8	7	2.2	112	4.4			2	0.2
3.25 to 3.49	82	2.0					4	1.2	78	3.1				
3.50 to 3.74	57	1.4					10	3.1	47	1.9				
3.75 to 3.99	4	0.1	1	0.9			1	0.3	2	0.1				
4.00 to 4.24	15	0.4	1	0.9			2	0.6	4	0.2			8	0.8
4.25 and over	105	2.6							95	3.8			10	1.0

---

[1] Includes 17 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.

[2] Less than one-tenth of 1 per cent.

The range of wages for employees in marble quarries was very wide. In 1902 there were 84 wage-earners getting less than $1 per day, and 105 receiving $4.25 and over. Between these extremes the employees were distributed in comparatively small groups, except between the rates from $1 to $1.74, where 58.5 per cent of the total number were included.

The quarrymen and stonecutters constituted 61.7 per cent of the total number of wage-earners reported. The wide range noticeable in the figures for all occupations combined is due almost entirely to the great variation in the rates paid to the quarrymen and stonecutters. More than half (59.3 per cent) of the total number were included in the three wage groups from $1 to $1.74, but most of the remainder were distributed in small groups from $1.75 to $4.25 and over. The difference between the wages paid to quarrymen and those paid to highly skilled stonecutters is very apparent in the figures presented.

The range of wages for the bulk of the engineers was from $1 to $2.74 per day, 91.1 per cent of the total number being included between those rates. Of the firemen nine-tenths received between $1 and $2.49, while 91.1 per cent of the machinists and other mechanics received from $1.25 to $2.74. Of the 22 boys under 16 years reported, 20 were paid less than 75 cents a day.

Under "all other wage-earners" are included 1,018 workmen. Almost six-tenths of these—59.3 per cent—were employed at rates between $1.25 and $1.74. Of the others 10.2 per cent received between 75 cents and $1.24 per day, and 27 per cent received from $1.75 to $2.74.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials was reported as $825,822, which was the largest item of expense other than wages. Of the $382,877 expended for miscellaneous expenses, $317,492, or 82.9 per cent, was paid for rent of offices, taxes, insurance, interest, and other sundries, and $65,385, or 17.1 per cent, was expended for royalties and rent of quarrying plant.

Mechanical power.—The total horsepower reported was 14,286, of which 10,748, or 75.2 per cent, was applied through 191 steam engines, and 3,413, or 23.9 per cent, was supplied by 15 water wheels. The remainder was classified as "other power." The total power was reported by 60 operators, Vermont leading with 53.1 per cent.

Production.—The annual production of marble from 1890 to 1902 is shown in the following table:

TABLE 16.—*Value of annual production of marble: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Total.	YEAR.	Total.
1890	$3,488,170	1897	$3,870,584
1891	3,610,000	1898	3,629,940
1892	3,705,000	1899	4,011,681
1893	2,411,000	1900	4,267,253
1894	3,199,585	1901	4,965,699
1895	2,825,719	1902	5,044,182
1896	2,859,136		

The gradual increase shown in 1890, 1891, and 1892 was followed by the great depression of 1893. An increase of $788,585 was shown for 1894, while in 1895 the value of production decreased to $2,825,719. This period of fluctuation was followed by a steady increase, except in 1898, until, in 1902, the value of product reached $5,044,182.

The following table shows the value of the annual production of marble, classified by uses, 1896 to 1902:

TABLE 17.—*Marble, classified by uses: 1896 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	VALUE OF PRODUCT					
	Rough, all uses.	Dressed.				All other uses.
		Building.	Monumental	Ornamental.	Interior decoration.	
1896	$563,690	$1,036,163	$813,146	$65,365	$320,904	$59,868
1897	477,856	1,074,646	1,547,469	9,010	576,983	184,620
1898	690,240	968,353	1,613,742	23,904	304,714	28,987
1899	640,585	1,170,208	1,650,155	92,942	389,040	62,901
1900	491,813	1,080,969	2,019,474	13,754	555,092	106,151
1901	591,667	1,236,023	1,948,892	126,576	1,008,482	54,059
1902	2,276,629	1,038,102	956,870	7,300	679,913	85,368

The following table shows the value of product of the principal marble producing states for 1902 and 1889, and ranks them according to these values:

TABLE 18.—*Production of marble, by principal states ranked by value of product: 1902 and 1889.*

STATE.	1902		1889	
	Value.	Rank.	Value.	Rank.
Vermont	$2,628,164	1	$2,169,560	1
Georgia	660,517	2	196,250	4
New York	577,298	3	351,197	3
Tennessee	518,256	4	419,467	2
Massachusetts	165,189	5		
Pennsylvania	160,123	6		
California	92,298	7	87,030	5
Washington	61,176	8		

In the number of quarries and value of output Vermont ranked first among the marble producing states in 1902. This has been the case since the very inception of the industry, though the proportional difference in output is being continually lessened as developments are made in other states. While the value of the product of Vermont has increased rather than diminished, the state in 1902 produced only 52.1 per cent of the output of the United States instead of 62.2 per cent, as in 1889. Other differences are equally marked. These are due mainly to the remarkable developments in Georgia, whereby the product was increased from $196,250 in 1889 to $660,517 in 1902; to the reopening of the long abandoned quarries in Berkshire county, Mass.; to developments near Avondale, in Chester county, Pa., in Adams and Stevens counties, Wash., and minor developments in Montana and Utah.

Occurrence.—The matter of the geographic distribution of marbles throughout the United States is of considerable economic importance. It will be noted by reference to Table 39 that a very large proportion of them are to be found in states bordering along the Appalachian mountain system. Recent developments show that materials of the same nature exist in the states west of the front range of the Rocky mountains, but thus far little more than development work has been done except in California and Washington. The entire region lying between the Appalachians and the front range of the Rocky mountains to the westward is quite unsupplied with anything that can properly be designated as marble, the geological conditions which were instrumental in producing the necessary alteration from the common limestone having here been inoperative.

With reference to the above distribution the following statement as to color, texture, and uses may be added, beginning with the most northerly of the marble producing states:

Vermont.—Marbles of a holocrystalline granular structure, varying from pure white to white veined with blue-gray and greenish to dark clouded blue-gray, occur in a somewhat interrupted belt extending throughout the entire length of the western part of the state. The

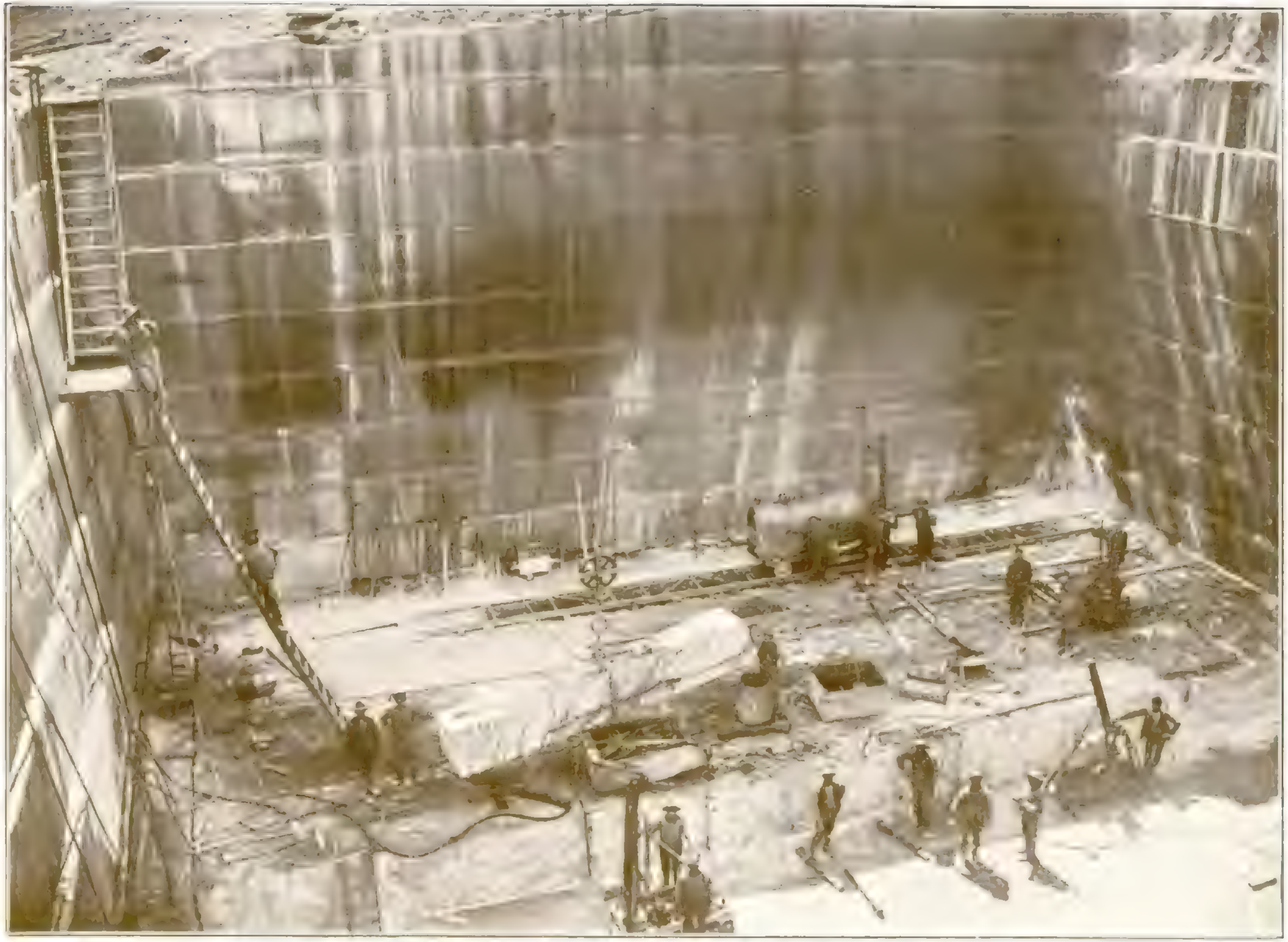

PLATE V.—INTERIOR VIEW OF MARBLE QUARRY NEAR TATE, PICKENS COUNTY, GEORGIA.

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quarry industry is developed to the greatest extent in Rutland county. Views showing the present condition of quarries at West Rutland and Proctor are given in Plates II, III, and IV. The stone is used for building, monumental, and decorative work. Chocolate, red, and variegated forms, used for tiling and interior decoration, are found in the vicinity of Mallet bay.

Massachusetts.—Holocrystalline rather coarsely granular building marbles of a white color are found in the various towns of Berkshire county.

New York.—Coarsely crystalline white and grayish dolomitic marbles, which are used mainly for building purposes, occur in Westchester and St. Lawrence counties.

Pennsylvania.—Holocrystalline granular marbles of a white and gray color, used mainly for building purposes, come from Montgomery and Chester counties.

Maryland.—Holocrystalline granular white marbles, used for general building purposes, are quarried in Baltimore county.

Georgia.—Holocrystalline coarsely granular white clouded and pink marbles, used mainly for building but also for interior decoration and monumental work, occur in Cherokee and Pickens counties. (See Plate V.)

Tennessee.—Pink, gray, and chocolate and white mottled stone, used almost wholly for interior decoration, is found in the region about Knoxville and Rogersville, in eastern Tennessee.

Washington.—A peculiar green or green-white mottled stone, consisting of an admixture of lime and magnesian carbonates, brucite, and serpentine, is being developed near Spokane, and worked into various art objects, such as vases, urns, and bowls, an entirely new departure in marble work.

A very large proportion of the marbles used for interior decoration, and, indeed, almost the entire supply of the verd antiques, are still imported, Italy, Africa, and Greece furnishing the largest amounts, although of late a considerable quantity has been brought from Norway. This importation is due in part to the more desirable quality of the material, and in part to the cheapness of foreign labor and low ocean freight rates.

A detailed summary showing the statistics of the marble industry for 1902 is given in Table 39.

SANDSTONES AND QUARTZITES.

Under the head of sandstones and quartzites, is included a widely variable series of rocks, composed, as the name suggests, largely of siliceous sand, which, through the influence of cementing materials or natural compression, has become sufficiently indurated to be utilized for building purposes. With them are also included certain rocks of similar origin but which, through the deposition of a siliceous cement, have become partially recrystallized and are known as quartzites. The so-called "Potsdam sandstone" of New York and the "jasper" of Sioux Falls, S. Dak., are good examples of this latter type. Here, too, are included the "bluestones" of New York and Pennsylvania, so widely used for flagging purposes, and the volcanic tuffs.

The following table presents comparative statistics for this industry for 1902, 1889, and 1880.

TABLE 19.—*Comparative summary: 1902, 1889, and 1880.*

	1902	1889	1880
Number of quarries	1,304	1,020	502
Number of operators	1,211	(1)	(1)
Salaried officials, clerks, etc.:			
Number	847	[2]290	(1)
Salaries	$713,579	(3)	(1)
Wage-earners:			
Average number	10,448	[2]18,458	[4]9,567
Wages	$6,153,060	[3]$6,785,214	(1)
Contract work	$500	(1)	(1)
Miscellaneous expenses	$878,780	$641,874	(1)
Cost of supplies and materials	$1,298,190	$1,311,799	[5]$27,571
Value of product	$10,601,171	[6]$12,505,663	$4,780,391

[1] Not reported.
[2] Foremen are included as wage-earners.
[3] Salaries are included in wages.
[4] Greatest number employed.
[5] Value of explosives.
[6] Includes bluestone, valued at $939,694, purchased by wholesale dealers.

There has been an actual increase in the number of quarries in operation, but this is due to the opening of small rural quarries, and is not accompanied by an increase in any of the expenditures except those classed as miscellaneous.

Employees and wages.—The total number of salaried officials and wage-earners was 11,295, the wage-earners contributing 10,448, or 92.5 per cent of this number. Their wages were $6,153,060, or 89.6 per cent of the total salaries and wages.

The following table shows the average number of wage-earners employed during each month:

TABLE 20.—*Average number of wage-earners employed during each month: 1902.*

MONTH.	Wage-earners.
January	5,727
February	5,794
March	7,765
April	10,405
May	12,778
June	13,406
July	13,368
August	13,152
September	12,705
October	11,990
November	10,506
December	7,790

The greatest number given employment for any one month was 13,406 in June; the least number was 5,727 in January. Sandstone quarries can not be operated during severe winter weather, as the stone must be quarried without an excess of moisture or frost, in order that it may weather well.

In the following table the distribution of wage-earners, according to daily rates of pay, is shown for the several classes of employees. The number receiving certain specified rates is given for each class, and also the percentages which these numbers form of the total number in their respective classes:

TABLE 21.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1] 10,448	100.0	529	100.0	241	100.0	478	100.0	7,117	100.0	76	100.0	2,007	100.0
Less than 0.50	4	(2)									4	5.3		
0.50 to 0.74	40	0.4	3	0.6			1	0.2	9	0.1	26	34.2	1	0.1
0.75 to 0.99	60	0.6	3	0.6	1	0.4	6	1.3	20	0.3	25	32.9	5	0.2
1.00 to 1.24	292	2.8	12	2.3	2	0.8	10	2.1	125	1.8	18	23.7	125	6.2
1.25 to 1.49	1,195	11.4	12	2.3	13	5.4	20	4.2	587	8.3	2	2.6	561	28.0
1.50 to 1.74	2,437	23.3	50	9.4	18	7.5	34	7.1	1,569	22.0			766	38.1
1.75 to 1.99	1,796	17.2	31	5.8	178	73.9	142	29.7	1,177	16.5	1	1.3	267	13.3
2.00 to 2.24	2,215	21.2	236	44.6	20	8.3	89	18.6	1,697	23.8			173	8.6
2.25 to 2.49	484	4.6	46	8.7	4	1.7	36	7.6	328	4.6			70	3.5
2.50 to 2.74	446	4.3	68	12.8	3	1.2	51	10.7	293	4.1			31	1.5
2.75 to 2.99	259	2.5	22	4.2	1	0.4	24	5.0	211	3.0			1	0.1
3.00 to 3.24	654	6.3	34	6.4			44	9.2	573	8.1			3	0.2
3.25 to 3.49	110	1.1	7	1.3			13	2.7	90	1.3				
3.50 to 3.74	314	3.0	3	0.6			3	0.6	304	4.3			4	0.2
3.75 to 3.99	26	0.2					3	0.6	23	0.3				
4.00 to 4.24	86	0.8	2	0.4	1	0.4	2	0.4	81	1.1				
4.25 and over	30	0.3							30	0.4				

[1] Includes 822 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.

[2] Less than one-tenth of 1 per cent.

The range of wages for men employed in sandstone and quartzite quarries is not wide. Of the 10,448 wage earners reported, 7,643, or 73.1 per cent, received between $1.25 and $2.24 per day. A very few, only 3.8 per cent, were paid less than $1.25, and the balance, 2,409, or 23.1 per cent, were distributed in small groups between $2.25 and $4.25. It will be noticed that there was a greater concentration of the several classes of wage-earners at a few rate groups in sandstone and quartzite quarries than in other stone quarries.

More than two-thirds of all the wage-earners were classed as quarrymen and stonecutters, 7,117 men having been reported under that head. More than six-tenths of them (62.3 per cent) were included in the three rate groups between $1.50 and $2.24. Those who received less than $1.50 per day numbered 741, and constituted 10.5 per cent of the total number, while 1,799 men, or 25.4 per cent, were distributed in small groups between $2.25 and $3.74.

The engineers, of whom 529 were reported, show a marked concentration at $2 a day, 236, or 44.6 per cent, being included in the single rate group, $2 to $2.24. For firemen an even greater concentration is shown, but at the next lower rate group; of the 241 firemen reported, 178, or 73.9 per cent, were paid between $1.75 and $1.99 per day. A wider range of wages is indicated by the figures for machinists and other mechanics. For them, too, the greatest concentration occurs in the $1.75 and $2 groups, but 14.9 per cent of them were paid less than $1.75 per day and 13.5 per cent received $3 or over.

Less than 1 per cent of the wage-earners were boys under 16 years, only 76 in all having been reported. Most of these boys were fairly well paid, 69 of them having received between 50 cents and $1.24 per day, and only 4 of them getting less than 50 cents.

Under the head of "all other wage-earners" are included 2,007 men, almost one-fifth of the total number reported. The range of wages for 1,594, or 79.4 per cent, was from $1.25 to $1.99 per day.

Supplies, materials, and miscellaneous expenses.—The comparative ease with which sandstone may be removed from the quarry bed, by the aid of modern machinery, tends largely to reduce the expenditure for supplies and materials, the cost of which in 1902 was $1,298,190. The total amount paid for miscellaneous expenses was $878,780, of which the amount paid for royalties and rent of quarrying plants formed 22.3 per cent, and rent of offices, taxes, insurance, and other sundries, 77.7 per cent.

Mechanical power.—The total primary power reported was 25,652 horsepower. Of this amount 789 steam engines contributed 24,631 horsepower, or 96 per cent; 7 gas or gasoline engines, 72 horsepower, or three-tenths of 1 per cent; 6 water wheels, 885 horsepower, or 3.5 per cent. The remainder was "other power." In addition 6 electric motors, with a total of 60 horsepower, were used during the census year by the operators who generated their own electricity.

Production.—The annual production of sandstones and quartzites from 1890 to 1902 is shown in the following table:

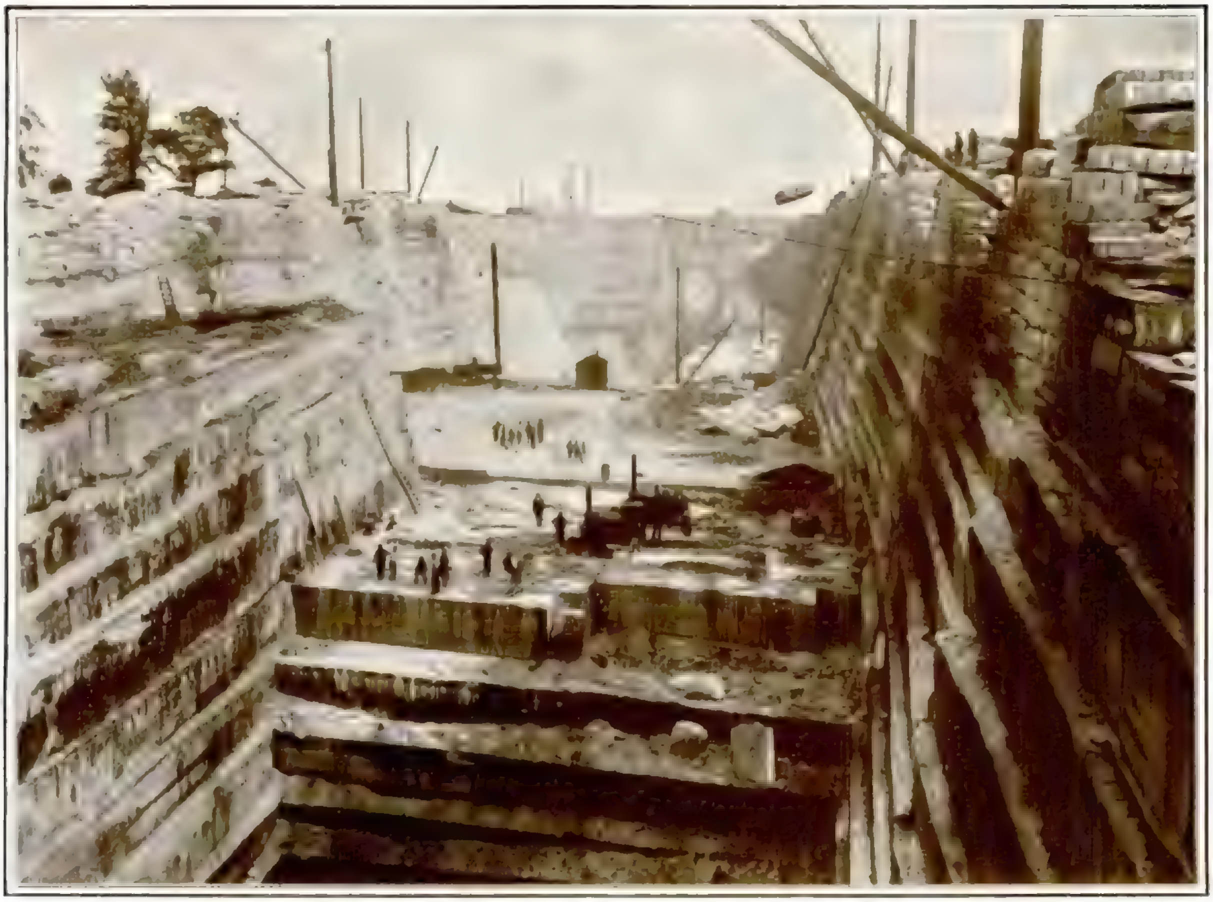

PLATE VI.—FIG. 1. VIEW NEAR WESTERN END OF GREAT CANYON SANDSTONE QUARRY, AMHERST, OHIO.

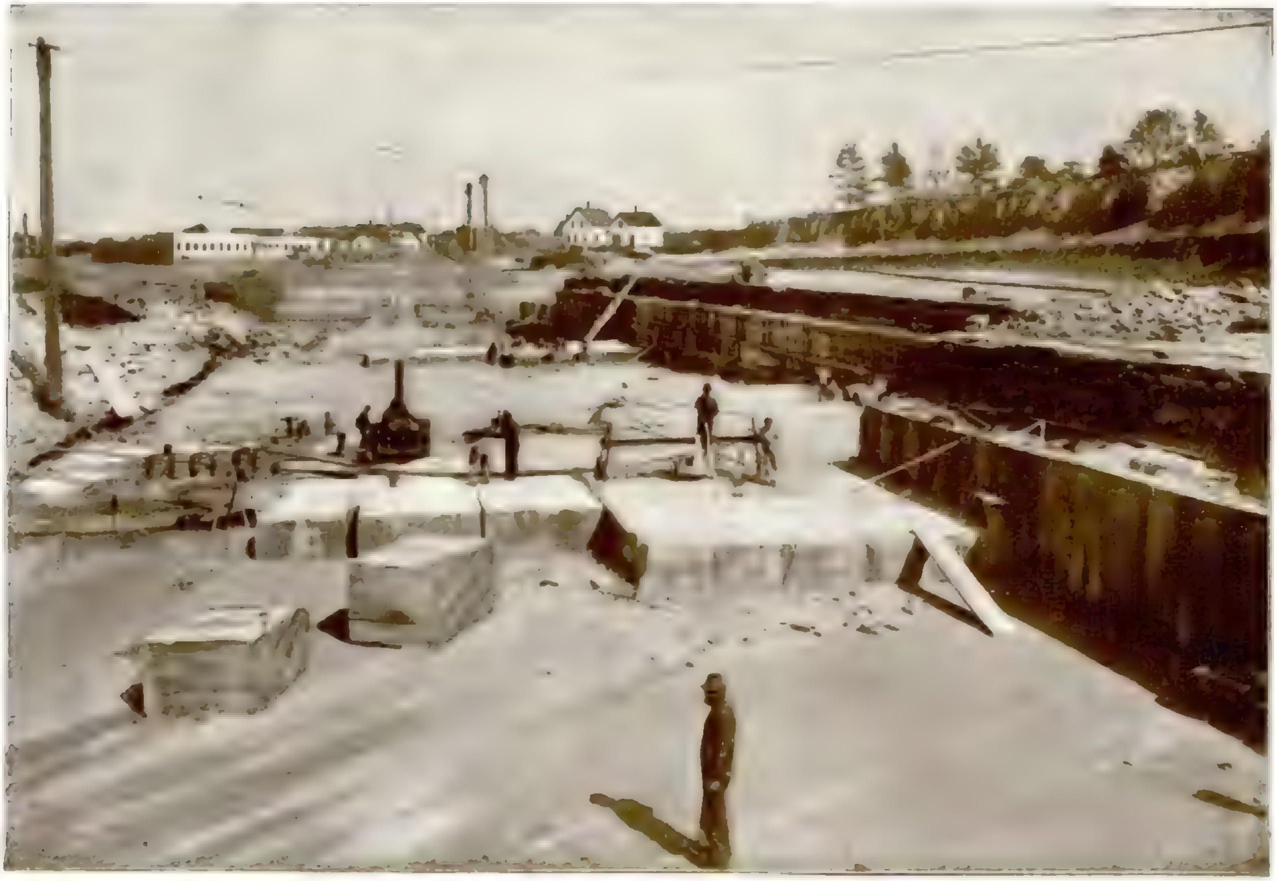

PLATE VI.—FIG. 2. VIEW OF SANDSTONE QUARRY AT BEREA, OHIO.

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Table 22.—*Value of annual production of sandstones and quartzites 1890 to 1902.*

[United States Geological Survey. "Mineral Resources of the United States".]

YEAR.	Total.	YEAR.	Total.
1890	$12,505,663	1897	$4,965,445
1891	10,200,000	1898	5,724,412
1892	9,915,500	1899	5,739,951
1893	5,295,151	1900	[1]6,471,384
1894	4,855,847	1901	[1]8,128,680
1895	4,961,314	1902	[1]10,601,171
1896	4,773,199		

[1] Does not include grindstones and whetstones.

The minimum production for the thirteen years was reached in 1896, when the product was valued at $4,773,199. The maximum was in 1890, when the value of the product was $12,505,663, or $1,904,492 more than the value for 1902.

The following table shows the value of products, classified by uses, from 1899 to 1902:

Table 23.—*Sandstones and quartzites, classified by uses: 1899 to 1902.*

[United States Geological Survey. "Mineral Resources of the United States".]

YEAR.	VALUE OF PRODUCT.			
	Building.		Flagging.	All other uses.
	Rough.	Dressed.		
1899	$1,995,162	$2,000,521	[1]$1,487,810	$256,000
1900	1,778,322	2,207,699	[1]2,071,887	413,476
1901		[2]4,875,973	1,024,199	2,228,508
1902	3,119,236	2,888,248	1,142,699	3,450,988

[1] Includes curbing.

[2] Includes rough building.

Of the $10,601,171 given as the total value of products in 1902, $6,007,484 was the value of the stone used for building purposes, the remainder being the value of the stone disposed of as riprap, rubble, paving, flagging, and crushed stone for road ballast, etc. A comparatively small amount was crushed and utilized as sand for glassmaking, as noted under "silica sand."

A comparison of the figures for 1889 and 1902 shows that the values increased more than elevenfold in Arizona and Texas, about sixfold in Idaho, fivefold in Wyoming, threefold in Arkansas and West Virginia, and twofold or more in California, Minnesota, Montana, Tennessee, and Utah. In 14 states the values decreased during these years. The largest per cents of decrease are as follows: New Mexico, 93; Connecticut, 86; Iowa, 81; Colorado, 70; Missouri, 63; and Washington, 59. There was a falling off of over 30 per cent in New Jersey and Ohio, and for Kansas, Massachusetts, and New York the decrease was between 25 and 30 per cent.

For comparative purposes the following table is given, showing the rank in value of product by states and territories for 1902 and 1889:

Table 24.—*Sandstones and quartzites, by principal states and territories ranked by value of product: 1902 and 1889.*

STATE OR TERRITORY.	1902		1889	
	Value.	Rank.	Value.	Rank.
Pennsylvania	$2,800,108	1	$1,990,894	3
Ohio	2,078,754	2	3,046,656	1
New York	1,408,609	3	2,005,740	2
Massachusetts	487,266	4	649,097	6
California	462,328	5	175,598	11
West Virginia	423,892	6	140,687	14
New Jersey	406,725	7	605,859	7
Colorado	396,161	8	1,324,098	4
Minnesota	347,472	9	131,979	15
Wisconsin	207,086	10	183,958	10
Michigan	188,073	11	246,570	8
Texas	165,565	12	14,651	27
Connecticut	128,579	13	920,061	5
Kentucky	128,470	14	117,940	16
South Dakota	110,789	15	98,570	17
Arizona	107,910	16	9,146	29
Kansas	105,599	17	149,259	13
Utah	105,011	18	48,306	20
Wyoming	90,691	19	16,760	26
Arkansas	85,917	20	25,074	24
Montana	85,152	21	31,648	23
Missouri	56,990	22	155,557	12
Alabama	42,706	23	13,965	22
Indiana	37,593	24	43,983	21
Illinois	32,290	25	17,896	25
Washington	30,725	26	75,906	19
Maryland	15,405	27	10,605	28
Iowa	15,061	28	80,251	18
Idaho	13,777	29	2,490	31
New Mexico	12,221	30	186,804	9
Tennessee	7,670	31	2,722	30
Nevada	6,115	32	....	....

A detailed summary showing the statistics of the industry for 1902 is given in Table 40.

Occurrence.—The sandstones are among the most variable and widely distributed of American building material. Those which have been most sought on account of their color and working qualities are the red-brown Triassic stones of the eastern United States, the light-gray to buff Carboniferous stones of the Mississippi valley, of which the so-called "Berea grit" is a familiar type, and the New York and Pennsylvania bluestones, utilized mainly for flagging purposes.

The sandstones are for the most part comparatively easy to work and, next to the granites, have been more generally employed for structural purposes than any other of our natural building materials. They are found interstratified with rocks of all geological horizons from the Cambrian down to the Tertiary and occupying all positions with relation to horizontality. In the mountainous regions the deposits are naturally more or less distorted and occupy more or less inclined positions. In the region of the Mississippi valley, where the geological agencies have been much less violent, the beds retain their original horizontal position and afford admirable facilities for quarry operations upon a large scale. It is upon these beds that some of the largest quarries in the country have been opened. Figures 1 and 2, Plate VI, show the position of the stone and the remarkable natural facilities for extraction as well as the great amount of development which has taken place at Amherst and Berea, Ohio.

SILICA SAND.

Silica or siliceous sand includes not only sand suitable for the manufacture of glass, but also a large quantity designated as engine and furnace sand and sand for other uses, it being impossible to separate the statistics. Of the value of product, $50,811 is for sand produced at regular sandstone quarries, being the waste or scrap stone crushed. In such instances the statistics of salaries, wages, and other expenditures, not being separable, have been included with those for sandstones and quartzites. At the census of 1880, glass sand was separately reported. Thirty-three mines were shown, at which 332 employees received wages amounting to $96,598, and the value of the product was $239,095. At the Eleventh Census, "sand for glass" was included with sandstone.

The following table is a summary for 1902:

TABLE 25.—*Summary: 1902.*

Number of quarries	26
Number of operators	20
Salaried officials, clerks, etc.:	
Number	35
Salaries	$27,228
Wage-earners:	
Average number	335
Wages	$149,114
Contract work	100
Miscellaneous expenses	$18,776
Cost of supplies and materials	$38,386
Product:	
Quantity (short tons)	445,903
Value	[1] $421,289

---

[1] The United States Geological Survey reports under "glass sand" (which is not included with the statistics for stone) 943,135 short tons, valued at $807,797, which includes glass sand obtained from banks. Census figures include only the sand produced at sandstone quarries by crushing the rock.

Of the 26 quarries, 10 were in Ohio, 14 in Pennsylvania, and 2 in West Virginia, the statistics of the last named being included with those of Pennsylvania to avoid disclosing the business of individual operators. These quarries were controlled by 20 operators, 5 of whom were individuals, 5 firms, and 10 incorporated companies; 7 of these companies were reported from Pennsylvania.

Employees and wages.—The 335 wage-earners constituted 90.5 per cent of the salaried employees and wage-earners, and the $149,114 paid as wages was 84.6 per cent of the total salaries and wages. The average number of wage-earners employed each month is shown in the detailed summary, Table 41. The greatest number, 380, was reported for September, and the least, 264, for February. This table shows also the average number of wage-earners at specified daily rates of pay by occupations. Of the 335 wage-earners, 261, or 77.9 per cent, were reported as receiving from $1.25 to $1.74 per day. There were 149, or 44.5 per cent, employed as quarrymen at rates ranging from 75 cents to $2.24 per day. The crushing of the stone entailed the employment of a large number of laborers and other workmen, who were reported as "all other wage-earners" and numbered 154, or 46 per cent, of the total. Silica sand is the only subdivision of the stone industry in which no boys under 16 years of age were reported.

Supplies, materials, and miscellaneous expenses. Supplies and materials costing $38,386 were reported, $13,598, or 35.4 per cent of the total, having been expended in Ohio. The miscellaneous expenses amounted to $18,776, of which $8,373, or 44.6 per cent, was for royalties and rent of quarrying plants, and $10,403, or 55.4 per cent, for rent of offices, insurance, and other sundries. Of the total, $11,210, or 59.7 per cent, was reported from Pennsylvania and West Virginia, and $7,566, or 40.3 per cent, from Ohio.

Mechanical power.—The total power owned was reported as 2,000 horsepower, of which 805 was reported from Ohio and 1,195 from Pennsylvania. Of this total, 1,980 horsepower was supplied by 33 steam engines, 16 of which were in Ohio.

Production.—The United States Geological Survey has not published annual statistics of glass sand except for 1885 and 1902, and these statistics are not comparable with those of the census, because they include sand from pits and banks as well as that crushed at sandstone quarries.

Chief among the sand producing states, in 1902, was Pennsylvania, where sand was found in all forms. This state was followed closely by Ohio, where deposits were generally those of sandstone requiring crushing and screening. A small quantity was reported from West Virginia.

The 16 quarries shown for Pennsylvania (including the 2 in West Virginia) produced 312,982 tons, or 70.2 per cent of the total production, the value being $269,015, or 63.9 per cent of the total value. Of this amount, 127,520 tons, valued at $105,367, was glass sand; 31,500 tons, valued at $24,000, building sand; 15,241 tons, valued at $18,896, furnace sand; and 138,721 tons, having a value of $120,752, was consumed for other purposes.

The 10 quarries in Ohio produced 132,921 tons, or 28.1 per cent of the total quantity; the value was $152,274, or 36.1 per cent of the total value. Of this quantity, 60,396 tons, valued at $59,348, was furnace sand; 20,036 tons, valued at $24,896, glass sand; 3,750 tons, valued at $3,000, engine sand; and 48,739 tons, valued at $65,030, was used for other purposes.

Occurrence.—Silica or siliceous sand is known to exist in several states as a sandstone, requiring crushing and screening; as a stone that readily disintegrates when exposed to the action of the elements, and needs only washing or burning to reduce the amount of organic matter and other impurities; or as beds of pure sand, requiring no treatment to prepare it for use.

Sand used in the manufacture of glass consists mainly of silica with alumina, and it may be iron, soda, lime, and potash in small and varying quantities. The value of the sand depends on its freedom from such impurities as tend to produce a discoloration of the glass.

A summary presenting detailed statistics of the silica sand industry, by states, for 1902, is given in Table 41.

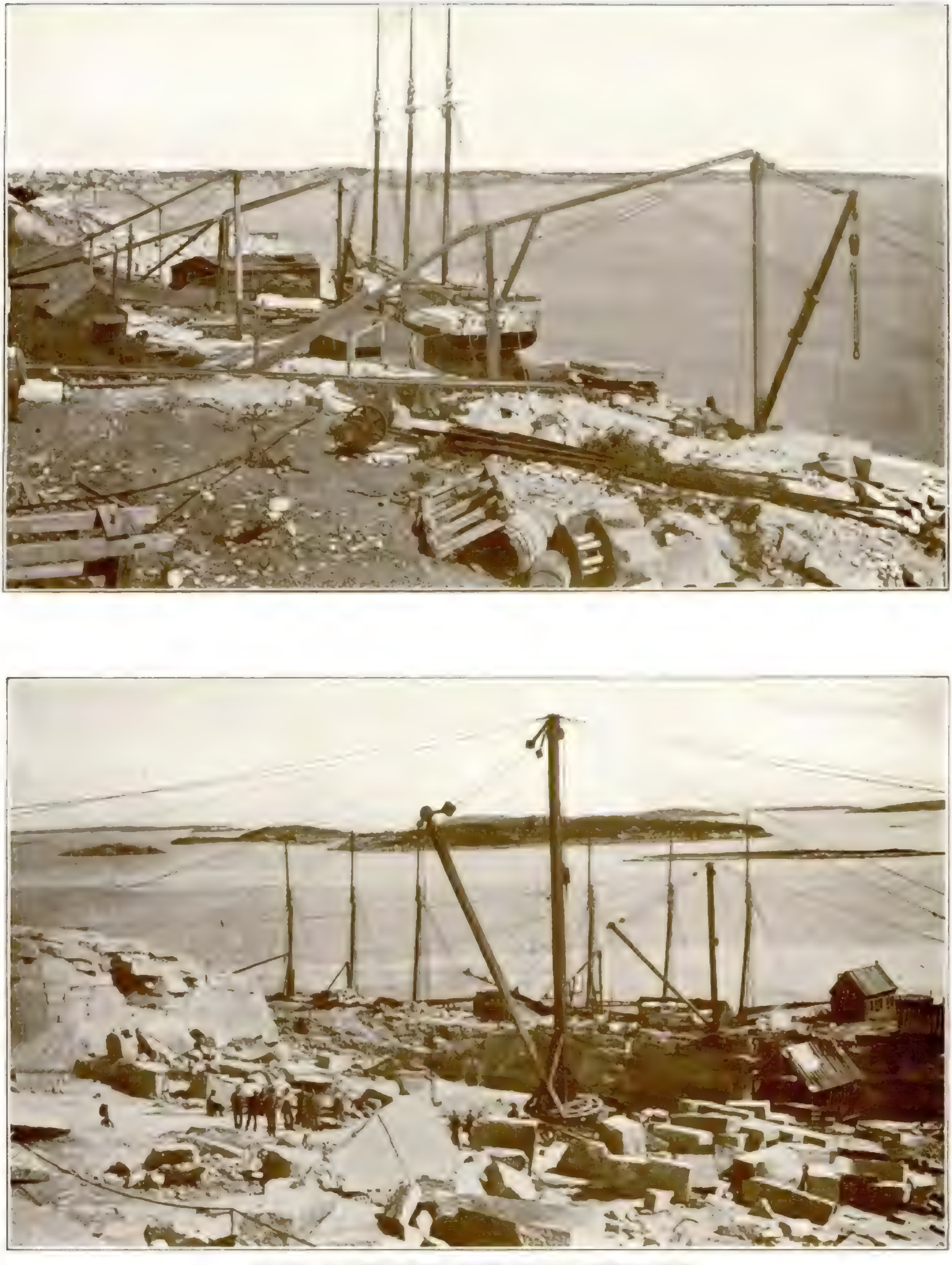

PLATE VII.—GRANITE QUARRY AT CROTCH ISLAND, MAINE (TWO VIEWS).

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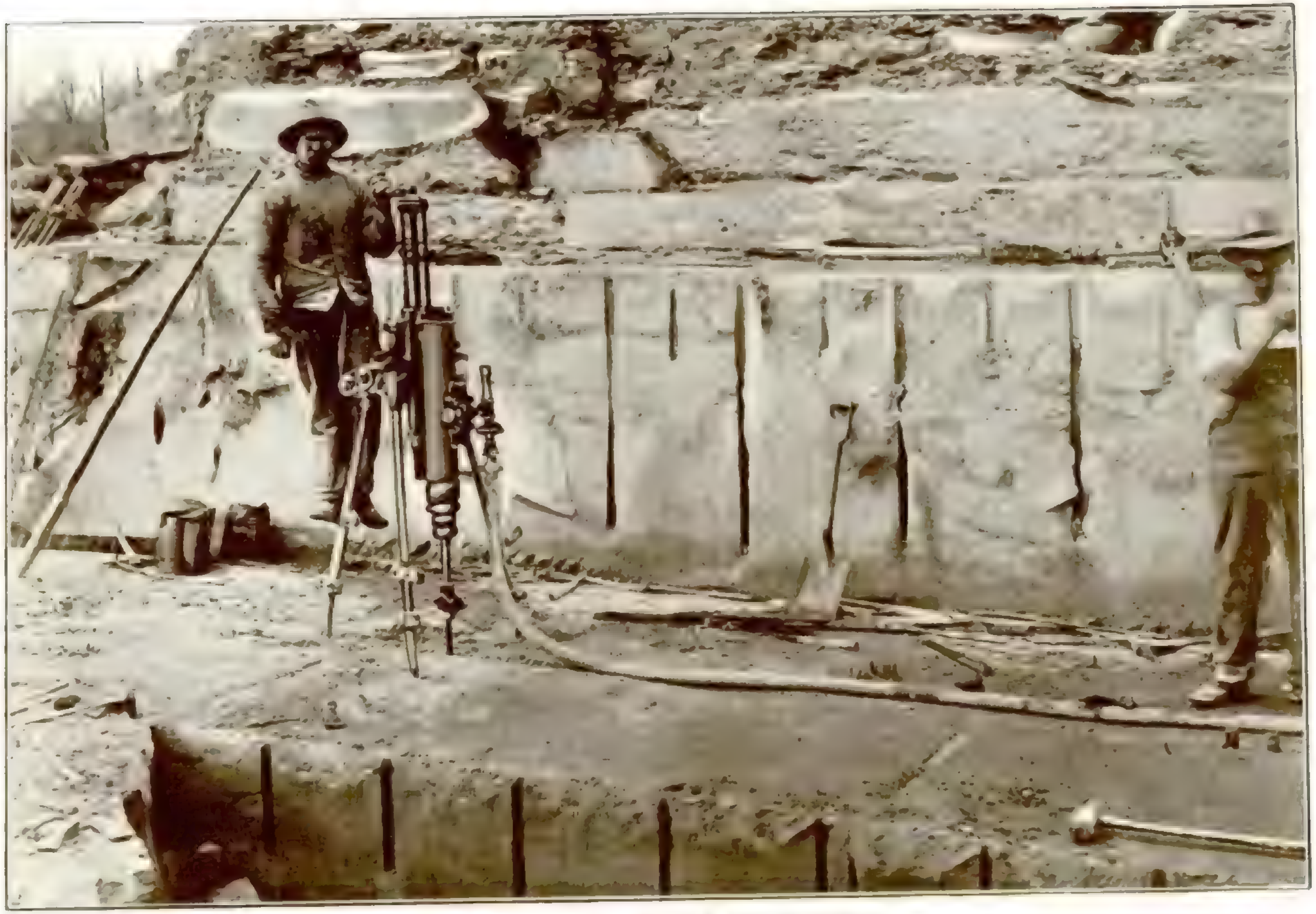

PLATE VIII.—STEAM DRILL USED IN STONE QUARRYING.

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SILICEOUS CRYSTALLINE ROCKS.

Under this classification is grouped a somewhat variable series of rocks, including not merely the true granites, but also the gneisses (the so-called striped, stratified, or bastard granites of the quarrymen), the syenites, the black granites or traps (diabases and gabbros), diorites, basalts, and andesites, and, in a few instances, the mica schists.

The varying mineral character and structural features of these rocks are noted below:

Granite.—A crystalline, granular, massive rock, consisting essentially of quartz, orthoclase, and mica or hornblende, with other minerals, as apatite and magnetite occurring in microscopic quantities.

Gneiss.—A rock differing from granite in that the various constituents are arranged in more or less parallel layers, giving the rock a banded or foliated appearance. It is often called stratified or bastard granite by the quarrymen.

Syenite.—A rock, limited in quantity, differing from granite only in the absence of quartz as an essential constituent, i. e., one consisting of orthoclase with one or more of the minerals of the mica, amphibole, or pyroxene group.

Elaeolite (nepheline) syenite.—A rock differing from syenite in that the mineral elaeolite (nepheline) wholly or in part replaces the feldspar. The "granite" near Hot Springs, Ark., is a good example of this rock.

Diabase and gabbro.—Rocks consisting essentially of augite or hypersthene and plagioclase feldspars with accessory apatite, magnetite, and frequently black mica. These are hard and massive rocks, often very dark gray to almost black in color, and in the case of the gabbro at Pleasant river, Me., known as black granite. In the majority of cases they are used only for road material.

Diorite.—A rock consisting essentially of hornblende or mica and plagioclase feldspar with other minerals in smaller proportions. In America this rock is little used for building material.

Basalt.—A lava composed essentially of augite and plagioclase feldspar. It occurs mainly in the Western states.

Andesite.—A rock composed of augite or hornblende and plagioclase feldspar. It is a lava, and its occurrence is limited mainly to the Western states.

Mica schist.—A rock composed essentially of quartz and mica, but with a pronounced schistose structure. It is little used for general building owing, in part, to its poor working qualities.

The statistics for siliceous crystalline rocks were separately presented at the censuses of 1880 and 1889. In the following table the statistics for these years and those for 1902 are shown for the purpose of comparison:

TABLE 26.—*Comparative summary: 1880 to 1902.*

	1902	1889	1880
Number of quarries	906	874	313
Number of operators	883	814	(1)
Salaried officials, clerks, etc.:			
Number	1,377	[2]222	(1)
Salaries	$1,227,885	(3)	(1)
Wage-earners:			
Average number	18,836	[2]22,091	[4]11,477
Wages	$11,072,996	[3]$9,620,485	(1)
Miscellaneous expenses	$840,206	$437,061	(1)
Cost of supplies and materials	$2,403,065	$1,446,485	[5]$70,397
Value of product	$18,257,944	$14,464,095	$5,188,998

[1] Not reported.
[2] Foremen included in wage-earners.
[3] Salaries included in wages.
[4] Greatest number employed.
[5] Value of explosives.

The increase in the number of quarries was 561, or 179.2 per cent, from 1880 to 1889, and 32, or 3.7 per cent, from 1889 to 1902. This difference in percentage of increase is due partly to the tendency toward combination noted in the discussion of Table 2. The value of the product of these quarries increased $9,275,097, or 178.7 per cent, from 1880 to 1889, and $3,793,849, or 26.2 per cent, from 1889 to 1902.

Development work was reported at 4 quarries located 1 each in California, Connecticut, Missouri, and New York. These quarries were controlled by 4 operators, 3 of them being incorporated companies. The capital stock and bonds issued by 2 of these companies amounted to $19,500. These 4 quarries gave employment to 83 wage-earners, who received $44,640 in wages.

There were 313 quarries reported idle during 1902. These were controlled by 313 operators.

Employees and wages.—The total number of salaried officials, clerks, etc., and wage-earners was 20,213, and they received $12,300,881 in salaries and wages. The wage-earners formed 93.2 per cent of this number, and their wages amounted to 90 per cent of the total.

Table 27 presents the average number of wage-earners employed during each month.

TABLE 27.—*Average number of wage-earners employed during each month: 1902.*

MONTH.	Wage-earners.
January	12,442
February	12,825
March	14,933
April	18,882
May	20,350
June	21,569
July	22,678
August	22,843
September	22,331
October	22,019
November	19,348
December	15,789

The foregoing table shows that the number of employees was greatest in August, when 22,843 wage-earners were given employment, and the least in January, for which month 12,442 were reported. This inconstancy of operation is explained in the discussion of Table 4.

The following table shows, for the several classes of employees, the number receiving certain specified rates of pay, and also the percentages which these numbers form of the total number in the class:

TABLE 28.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	[1]18,836	100.0	658	100.0	164	100.0	1,094	100.0	14,474	100.0	206	100.0	2,240	100.0
Less than 0.50	37	0.2									36	17.5	1	(2)
0.50 to 0.74	133	0.7	1	0.2	3	1.8	1	0.1	52	0.4	56	27.2	20	0.9
0.75 to 0.99	573	3.0	5	0.8	7	4.3	9	0.8	350	2.4	49	23.8	153	6.8
1.00 to 1.24	1,282	6.8	11	1.7	6	3.7	18	1.6	958	6.6	59	28.6	230	10.3
1.25 to 1.49	2,096	11.1	17	2.6	18	11.0	25	2.3	1,583	10.9	5	2.4	448	20.0
1.50 to 1.74	3,546	18.8	53	8.0	25	15.2	73	6.7	2,655	18.3	1	0.5	739	33.0
1.75 to 1.99	3,045	16.2	89	13.5	33	20.1	85	7.8	2,648	18.3			190	8.5
2.00 to 2.24	2,483	13.2	225	34.2	32	19.5	199	18.2	1,758	12.2			269	12.0
2.25 to 2.49	692	3.7	96	14.6	9	5.5	107	9.8	435	3.0			45	2.0
2.50 to 2.74	1,141	6.1	93	14.1	23	14.0	185	16.9	814	5.6			26	1.2
2.75 to 2.99	1,364	7.2	20	3.0	4	2.4	172	15.7	1,163	8.0			5	0.2
3.00 to 3.24	1,608	8.5	37	5.6	2	1.2	158	14.4	1,318	9.1			93	4.2
3.25 to 3.49	480	2.5	3	0.5	2	1.2	38	3.5	428	3.0			9	0.4
3.50 to 3.74	199	1.1	4	0.6			15	1.4	175	1.2			5	0.2
3.75 to 3.99	23	0.1	4	0.6					18	0.1			1	(2)
4.00 to 4.24	125	0.7					9	0.8	110	0.8			6	0.3
4.25 and over	9	0.1							9	0.1				

[1] Includes 528 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.
[2] Less than one-tenth of 1 per cent.

The figures presented in the above table indicate a wide range in the daily rates of pay. Of the total number reported, 743, or 3.9 per cent, received less than $1 per day, and 836, or 4.5 per cent, received $3.25 per day or over. For the remaining 17,257 wage-earners, constituting 91.6 per cent of the total number, the range of wages was from $1 to $3.24 per day.

About three-fourths (76.8 per cent) of all the wage-earners reported were classified as quarrymen and stonecutters. Their rates conform very closely to those for all occupations combined, 92 per cent of the total number having received between $1 and $3.24 per day, as compared with 91.6 per cent for all occupations combined. An examination of the figures for quarrymen and stonecutters shows a marked concentration at the rates from $1.25 to $2.24 per day, then a slight falling off, and again a concentration for the rates from $2.75 to $3.24 per day. This indicates the difference between the rates paid to quarrymen and those paid to stonecutters, who are more skilled than the quarrymen.

There were 658 engineers reported, of whom 503, or 76.4 per cent, received between $1.75 and $2.74 per day. The range of wages for 65.8 per cent of the firemen was from $1.25 to $2.24 per day, 9.8 per cent having received less than $1.25, and 24.4 per cent, $2.25 or over. Rates were considerably higher for machinists and other mechanics, three-fourths of them having been paid from $2.00 to $3.24 per day.

The number of boys under 16 years reported was 206, of whom 91 were in the New England states and 46 were in South Carolina and Georgia. The rates of pay for 164 of these boys were between 50 cents and $1.24 per day; of the others, 36 received less than 50 cents and 6 received $1.25 or over.

The group of "all other wage-earners" includes 2,240 men, or 11.9 per cent of the total number of wage-earners reported. The range of wages for 2,029 of them was from 75 cents to $2.24 per day. The number receiving $1.50 per day was probably greater than that at any other rate, since the wage group, $1.50 to $1.74, includes a much larger number than is included in any other group.

Supplies, materials, and miscellaneous expenses.—The total cost of supplies and materials was $2,493,065. Of this amount $509,702, or 20.5 per cent, was expended in Massachusetts; $272,888, or 10.9 per cent, in Vermont; and $217,548, or 8.7 per cent, in Maine. Smaller amounts were reported from the other states.

The amount paid for royalties and rent of quarrying plants was $194,892, or 24.1 per cent of the total, and $615,314, or 75.9 per cent, was paid for rent of offices, taxes, and other sundries.

Mechanical power.—Primary power aggregating 46,986 horsepower was reported; 44,189, or 94 per cent, was applied through 950 steam engines; 275, or six-tenths of 1 per cent, was generated by 26 gas or gasoline engines; and 1,506, or 3.2 per cent, by 15 water wheels. Under "other power," 510 horsepower, or 1.1 per cent, was reported. The rented horsepower was 506, or 1.1 per cent, of which 471 was electric. In addition, 23 electric motors, having a capacity of 442 horsepower, were owned by the operators reporting them.

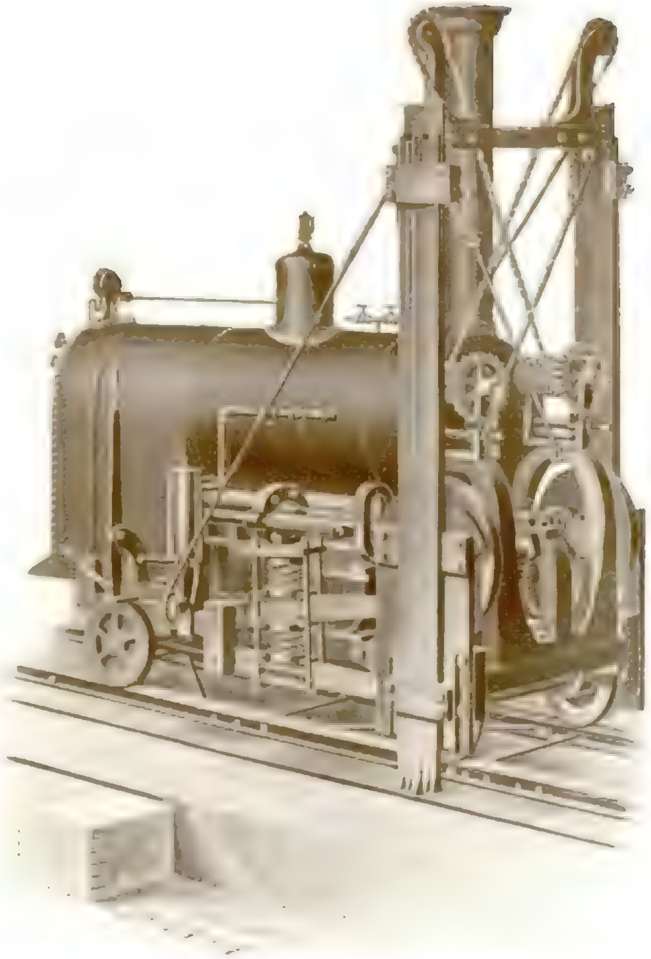

PLATE IX.—DOUBLE GANG MARBLE AND LIMESTONE CHANNELING MACHINE.

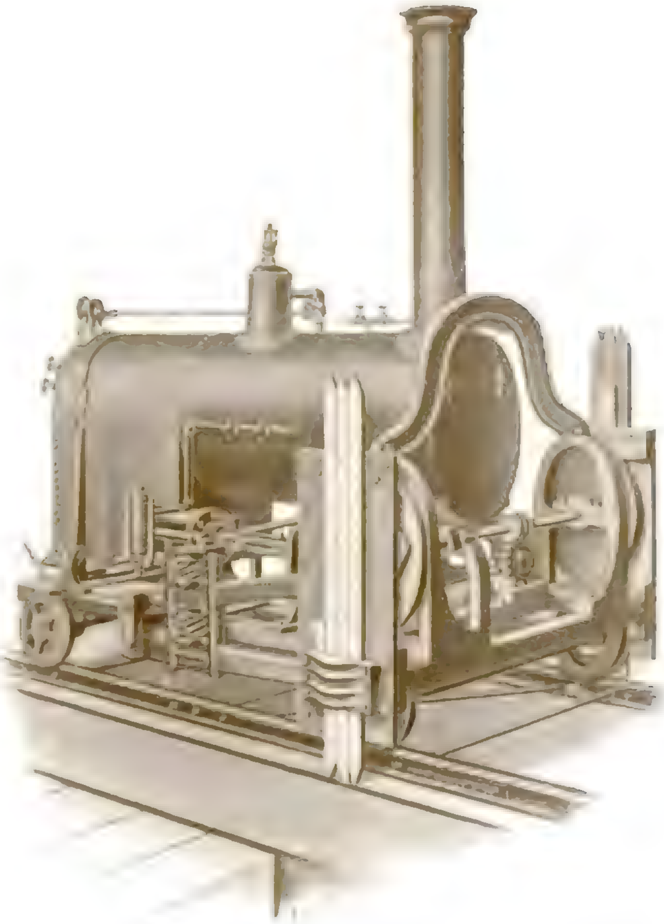

PLATE X.—DOUBLE GANG SANDSTONE CHANNELING MACHINE.

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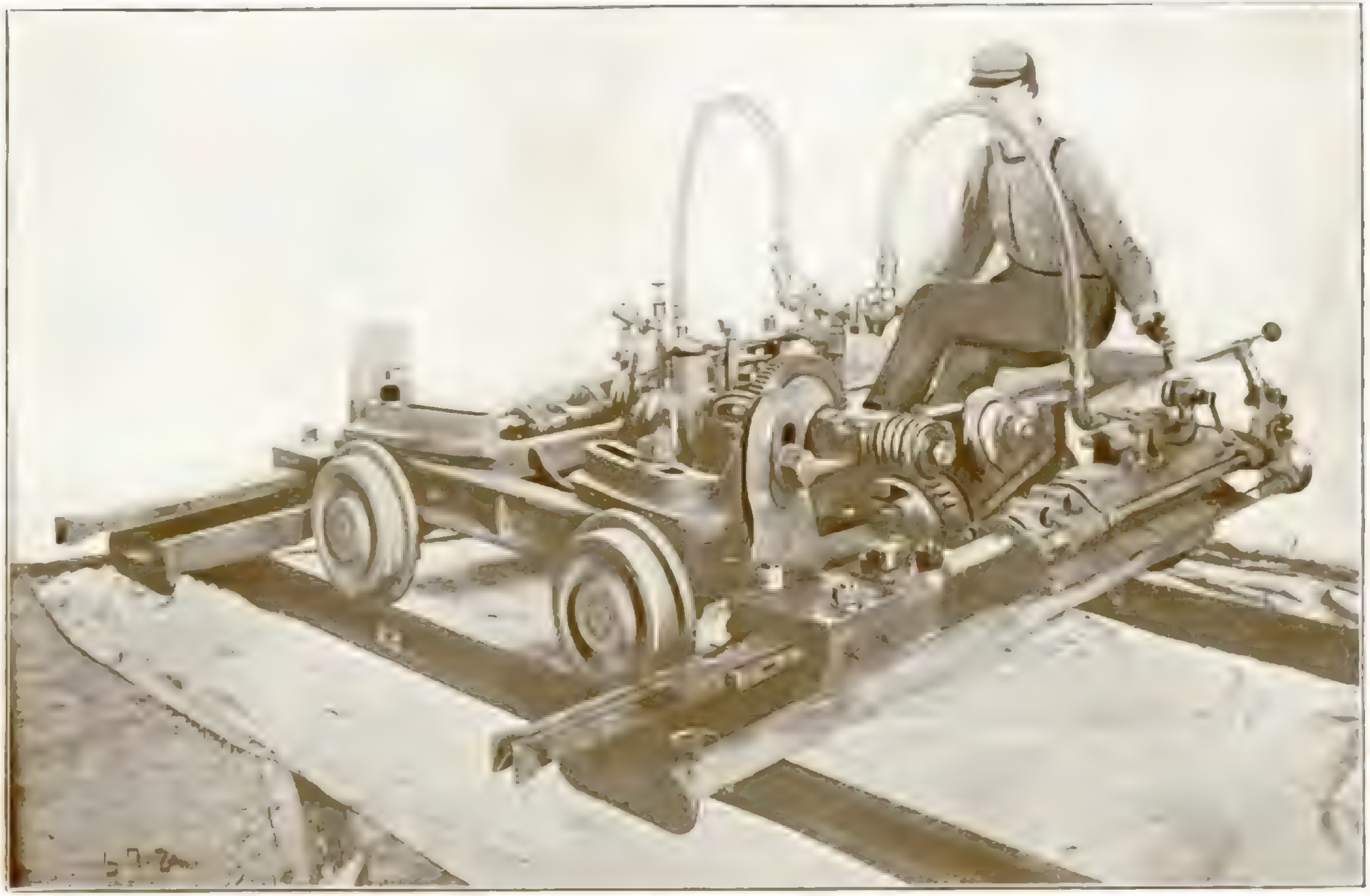

PLATE XI.—CHANNELING MACHINE FOR UNDERCUTTING.

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Production.—The following table shows the production of siliceous crystalline rocks, classified by uses, 1896 to 1902:

TABLE 29.—VALUE OF ANNUAL PRODUCTION OF SILICEOUS CRYSTALLINE ROCKS, CLASSIFIED BY USES: 1896 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	VALUE OF PRODUCT						
	Rough, all uses.	Dressed.		Made into paving blocks.	Curbing.	Crushed, all uses.	All other uses.
		Building.	Monumental.				
1896	$2,232,692	$2,282,077	$1,437,065	$1,231,729	$156,392	$514,550	$130,499
1897	2,363,031	2,565,636	1,414,502	1,140,417	160,195	991,867	269,427
1898	1,826,865	1,874,990	1,462,568	854,151	683,407	1,592,925	1,129,480
1899	2,351,931	2,625,289	1,687,967	989,499	545,655	2,044,797	1,393,201
1900	2,455,276	3,233,224	1,598,842	1,006,298	593,209	2,571,899	1,216,871
1901	3,496,574	3,781,294	1,457,557	1,821,431	670,708	3,003,443	1,755,959
1902	[1] 4,433,152	4,859,750	2,284,755	1,523,776	823,846	3,211,780	1,120,885

[1] Includes building stone valued at $2,175,082, monumental stone valued at $1,714,156, and stone for other uses valued at $543,914.

Of the total value of product, $18,257,944, in 1902, a value of $7,034,832 was used for building purposes and $3,998,911 for monumental work. The remaining material to the value of $7,224,201 was utilized for a variety of purposes, but especially for paving blocks and as crushed stone for macadam. The introduction of machinery has rendered possible the utilization of the granites and other hard rocks in monumental work to an extent that was quite impossible when the stone was dressed by hand. The use of stone for macadam is largely a development of the past twenty years, and the demand for it for this purpose has caused the great increase in the number of quarries of trappean rock. This demand for crushed stone likewise enables the quarries worked mainly for building or monumental stone to dispose of their waste. The material used for macadam depends, however, to a considerable extent on the kind of rock that is available in neighboring sources. While the trappean rocks have proved most desirable for this purpose, the total absence of material of this type from the great interior Mississippi valley has caused the substitution largely of limestone and, in some cases, of sandstone.

The following table shows the value of product of siliceous crystalline rocks from 1890 to 1902:

TABLE 30.—*Value of annual production of siliceous crystalline rocks: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Value of product.	YEAR.	Value of product.
1890	$14,464,095	1897	$8,905,075
1891	13,867,000	1898	9,424,406
1892	12,642,000	1899	11,618,239
1893	8,808,934	1900	12,675,617
1894	10,029,156	1901	15,976,963
1895	8,894,328	1902	18,257,944
1896	7,944,994		

The value of the product decreased from 1890 to 1894, then increased, declining again in 1895 and 1896, since which time it has constantly increased.

As shown in Table 42, there were 204 quarries in Massachusetts and 110 in Maine. The number of quarries in the other states varied from 74 in Vermont to 1 each in Arizona and Nevada. Indian Territory also reported 1. In the following comparative table the values of the products for 1902, 1889, and 1880 are given, and the states are ranked according to these values.

TABLE 31.—*Production of siliceous crystalline rocks, by principal states ranked by value of product: 1902, 1889, and 1880.*

STATE.	1902		1889		1880	
	Value.	Rank.	Value.	Rank.	Value.	Rank.
Massachusetts	$3,451,397	1	$2,503,503	1	$1,329,515	1
Maine	2,659,450	2	2,225,839	2	1,175,296	2
Vermont	1,570,423	3	581,870	9	59,675	13
New Hampshire	1,147,097	4	727,531	7	303,066	6
California	1,137,679	5	1,329,018	3	172,450	9
New Jersey	948,474	6	125,678	12	99,000	11
Connecticut	812,141	7	1,061,202	4	467,225	4
Georgia	808,779	8	752,481	6	64,180	12
Maryland	758,203	9	447,189	11	224,000	7
Rhode Island	733,625	10	931,216	5	625,000	3
Pennsylvania	661,062	11	625,252	8	211,454	8
New York	651,014	12	222,777	17	10,000	17
South Carolina	598,848	13	47,611	20		
Minnesota	478,909	14	356,782	13	13,075	15
Wisconsin	369,137	15	286,095	16		
North Carolina	338,750	16	146,627	19		
Virginia	282,046	17	332,548	14	331,928	5
Delaware	276,753	18	211,194	18	12,600	16
Missouri	157,708	19	500,642	10	110,000	10
Washington	147,253	20			1,044	18
Montana	77,000	21				
Colorado	66,023	22	314,673	15	41,400	14
Texas	60,003	23	22,550	22		
Oregon	38,429	24	44,150	21		
Arkansas	12,115	25				
Utah	1,479	26	8,700	23		

Massachusetts and Maine occupied in 1902 the same relative position that they held at the Tenth and Eleventh censuses. California, however, dropped from the third to the fifth place in the list, while Vermont advanced from the ninth to the third, and New Hampshire from the seventh to the fourth. The changes in rank are due in some cases to a decrease in production, as in the case of California, and in others to an increase, as in the case of Vermont and New Hampshire. Georgia, which made such a remarkable increase between the Tenth and Eleventh censuses, causing it to advance from twelfth to sixth in rank, has dropped to eighth, although there has been an actual increase in the product.

The detailed statistics of the industry for 1902 are given in Table 42.

During the early history of the industry, when railroads were few, transportation of material as heavy as stone was largely by water. Hence it naturally followed that quarries situated close to the water's edge, like those of Vinalhaven and Crotch Island, Me. (see Plate VII), had a great advantage, and for a long time practically controlled the market. With the multiplicity of railroads, however, and the growing demand of inland cities remote from waterways, inland quarries at first wholly inaccessible have become important factors, and as a consequence the coast states have, to a considerable extent, lost prestige.

Of the quarries developed during the last decade, on account of the quality as well as quantity of material they furnish, those in the vicinity of Barre, Vt., and Montello, Wis., are of greatest interest. The quarry near Montello furnishes a beautiful, compact, dark red-brown granite admirably adapted for monumental work.

SLATE.

The materials brought together in this report under the head of slate are argillaceous rocks, which, through the process of shearing and incidental chemical activity, have undergone a partial metamorphism, resulting in the development of a pronounced tendency to split along certain planes, which may or may not be parallel with the original bedding, into thin sheets suitable for roofing purposes. It is necessarily a consequence that such are restricted to the regions of pronounced earth movements, such as have resulted in the formation of mountain ranges.

The decrease in the number of quarries since 1889 has not been attended by a decrease in any of the other items and is largely due to consolidation of interests.

The apparent decrease in the number of wage-earners is due to the methods employed by the various censuses in finding the average and in part to the introduction of machinery. The steady increase in the amount paid as wages indicates that the difference shown in the "average number" is not due to an actual decrease in the number of wage-earners. The production increased $2,213,538, or 63.6 per cent, from 1889 to 1902.

Census statistics for slate quarries were shown as early as 1850, when the value of product was reported as $29,056, the number of quarries being 5. At the census of 1860, there were 22 quarries, with a production valued at $287,150. The census of 1870 was the first at which the mining industries were separately shown. The following comparative summary includes the statistics from 1870 to 1902:

TABLE 32.—*Comparative summary: 1870 to 1902.*

	1902	1889	1880	1870
Number of quarries	199	212	94	(1)
Number of operators	171	(1)	(1)	[2]101
Salaried officials, clerks, etc.:				
Number	437	175	(1)	(1)
Salaries	$334,879	(4)	(1)	(1)
Wage-earners:				
Average number	5,920	[3]6,085	[5]3,033	1,749
Wages	$3,177,459	[4]$2,218,982	(1)	$815,731
Miscellaneous expenses	$446,115	$261,026	(1)	(1)
Cost of supplies and materials	$680,361	$282,114	[6]$82,799	$119,501
Value of product	$5,696,051	$3,482,513	$1,529,985	$1,311,492

[1] Not reported.
[2] Establishments.
[3] Foremen included in wage-earners.
[4] Salaries included in wages.
[5] Greatest number employed.
[6] Value of explosives.

There were 3 quarries, all in Pennsylvania, for which development work was reported for 1902. One salaried employee received a salary of $900 and 13 wage-earners were paid $4,952 in wages.

The total capital stock and bonded indebtedness in the slate industry amounted to $11,323,565, of which Pennsylvania reported $3,356,940, or 29.7 per cent; Maine, $1,645,800, or 14.5 per cent; New York, $1,018,500, or 9.0 per cent; Maryland, $316,300, or 2.8 per cent; Vermont, $275,600, or 2.4 per cent; New Jersey, $77,000, or seven-tenths of 1 per cent; and all other states $4,633,425, or 40.9 per cent.

Employees and wages.—There were 6,357 salaried employees and wage-earners, who were paid $3,512,338; of this number the 5,920 wage-earners formed 93.1 per cent, and the $3,177,459 paid them in wages was 90.5 per cent of the total salaries and wages.

The following table shows the average number of wage-earners employed during each month:

TABLE 33.—*Average number of wage-earners employed during each month: 1902.*

MONTH.	Wage-earners.
January	5,265
February	5,302
March	5,468
April	5,898
May	6,136
June	6,143
July	6,302
August	6,353
September	6,341
October	6,223
November	5,947
December	5,659

The largest number of wage-earners, 6,353, was reported for August, and the least, 5,265, for January, a variation of 1,088.

In the following table, the distribution of wage-earners, according to daily rates of pay, is given by occupations:

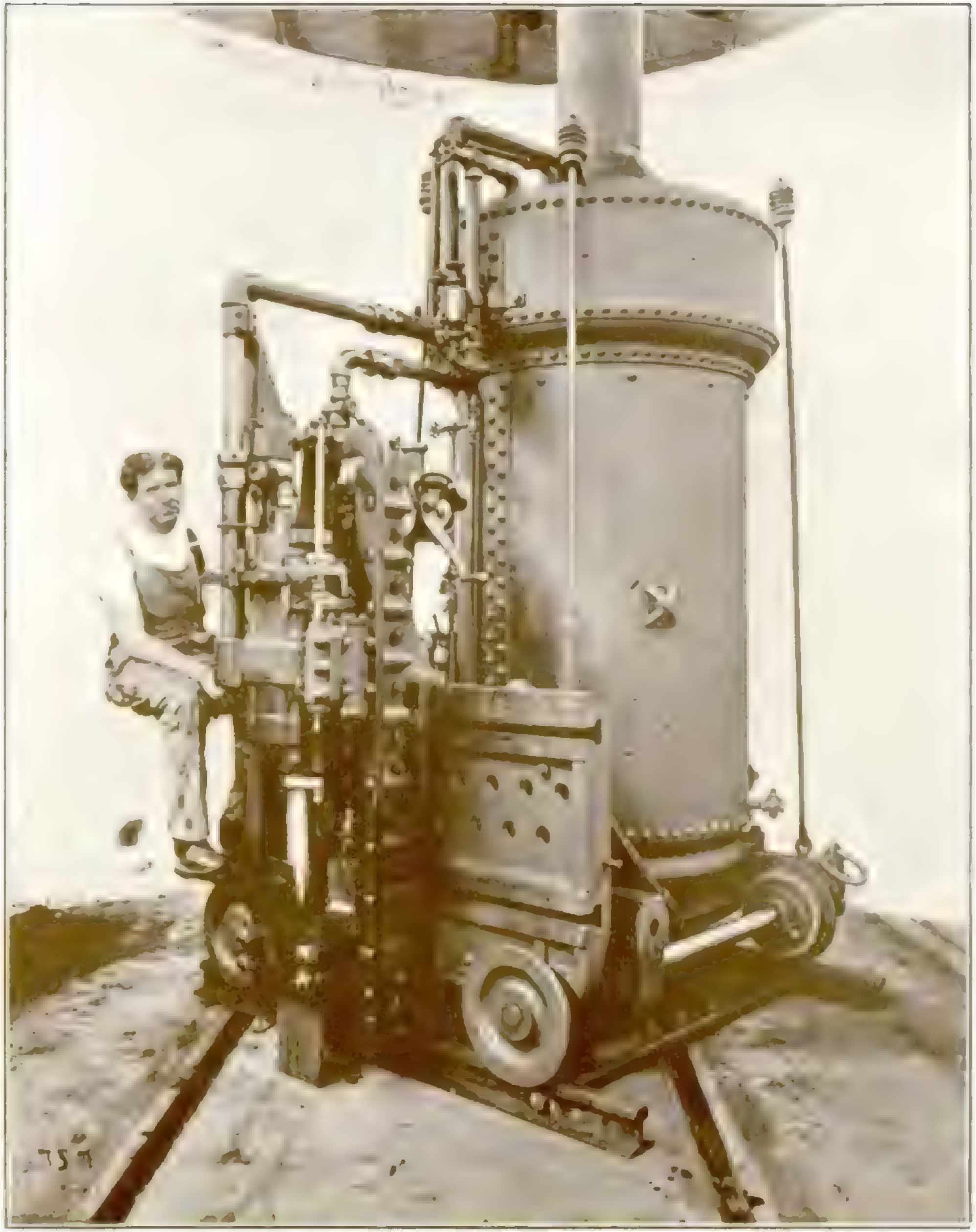

PLATE XII.—TRACK CHANNELER, WITH BOILER.

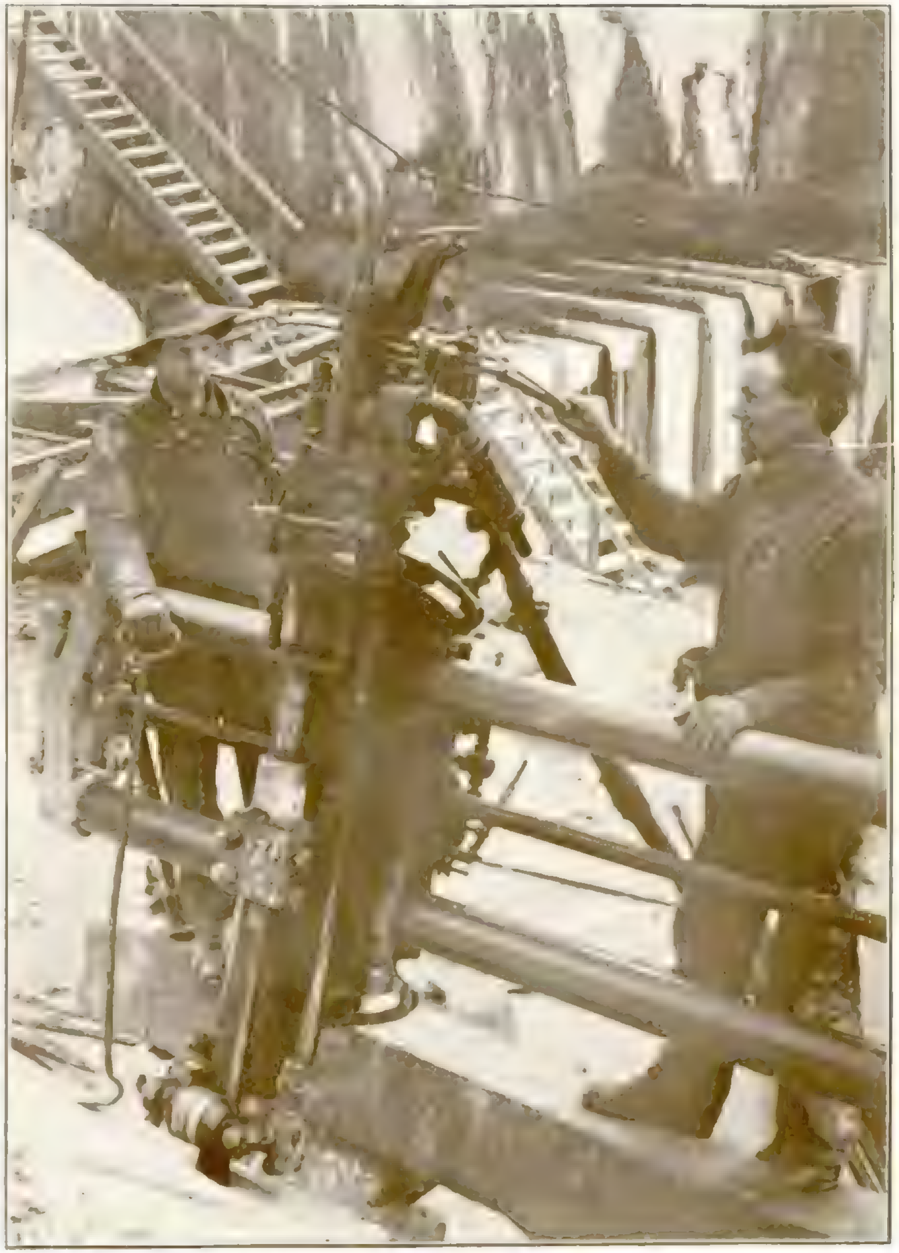

PLATE XIII.—QUARRY BAR CHANNELING MACHINE.

TABLE 34.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		QUARRYMEN AND STONECUTTERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number	Per cent of total.	Average number.	Per cent of total.
Total	[1] 5,920	100.0	279	100.0	87	100.0	137	100.0	3,656	100.0	169	100.0	1,592	100.0
Less than 0.50	7	0.1									7	4.1		
0.50 to 0.74	72	1.2							3	0.1	66	39.1	3	0.2
0.75 to 0.99	101	1.7	2	0.7					7	0.2	75	44.4	17	1.1
1.00 to 1.24	290	4.9	20	7.2	4	4.6			117	3.2	20	11.8	129	8.1
1.25 to 1.49	983	16.6	81	29.0	11	12.7	6	4.4	185	5.1	1	0.6	699	43.9
1.50 to 1.74	1,145	19.4	48	17.2	29	33.3	17	12.4	588	16.1			463	29.1
1.75 to 1.99	658	11.1	38	13.6	18	20.7	22	16.0	505	13.8			75	4.7
2.00 to 2.24	1,369	23.1	61	21.9	13	14.9	39	28.5	1,160	31.7			96	6.0
2.25 to 2.49	671	11.3	7	2.5	5	5.8	27	19.7	600	16.4			32	2.0
2.50 to 2.74	349	5.9	16	5.7	5	5.8	13	9.5	263	7.2			52	3.3
2.75 to 2.99	161	2.7	1	0.4	1	1.1	3	2.2	142	3.9			14	0.9
3.00 to 3.24	105	1.8	4	1.4			5	3.6	86	2.3			10	0.6
3.25 to 3.49	4	0.1	1	0.4	1	1.1	2	1.5						
3.50 to 3.74	4	0.1					2	1.5					2	0.1
3.75 to 3.99														
4.00 to 4.24														
4.25 and over	1	(2)					1	0.7						

[1] Includes 800 wage-earners paid in accordance with the amount of work done, for whom average daily earnings are shown.
[2] Less than one-tenth of 1 per cent.

As shown by the above table, the range of wages for practically all of the employees in slate quarries was from $1 to $2.74 per day, 5,465, or 92.3 per cent of the total number, having been reported at rates between those limits.

Quarrymen and stonecutters to the number of 3,656 were reported. Of these 2,853, or 78 per cent were paid from $1.50 to $2.49 per day. Of the remainder 302, or 8.3 per cent, received between $1 and $1.49 per day, and 491, or 13.4 per cent, received from $2.50 to $3.24. Probably a greater number were employed at $2 per day than at any other single rate, as the group $2 to $2.24 includes 1,160 men, constituting 31.7 per cent of the total number.

The range of wages for 228 engineers, 81.7 per cent of the total number reported, was between $1.25 and $2.24 per day, and of the 87 firemen, 71 were included between the same rates. The rates of pay for 118 machinists and other mechanics, out of a total of 137, were between $1.50 and $2.74 per day.

The boys under 16 years employed in slate quarries in 1902 numbered 169. Of these, 115 were reported from Pennsylvania and 38 from Vermont. The rates for 141 of these boys, constituting 83.5 per cent of the whole number, were between 50 and 99 cents per day.

The group of "all other wage-earners" formed slightly more than one-fourth of all the wage-earners reported. Their wages ranged from 50 cents to $3.74 per day, but 74.7 per cent of them received from $1.25 to $1.74, the proportion at lower or higher rates being comparatively small.

The following table shows the distribution of wage-earners according to daily rates of pay, by states:

TABLE 35.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY PRINCIPAL STATES: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			PENNSYLVANIA.			VERMONT.			ALL OTHER STATES.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	5,920	100.0		3,426	100.0		1,639	100.0		855	100.0	
Less than 0.50	7	0.1	100.0	1	(1)	100.0				6	0.7	100.0
0.50 to 0.74	72	1.2	99.9	59	1.7	99.9	3	0.2	100.0	10	1.2	99.3
0.75 to 0.99	101	1.7	98.7	53	1.5	98.3	28	1.7	99.8	20	2.4	98.1
1.00 to 1.24	290	4.9	97.0	95	2.8	96.8	43	2.6	98.1	152	17.8	95.7
1.25 to 1.49	983	16.6	92.1	778	22.7	94.0	122	7.4	95.5	83	9.7	77.9
1.50 to 1.74	1,145	19.4	75.5	514	15.0	71.3	455	27.8	88.1	176	20.6	68.2
1.75 to 1.99	658	11.1	56.1	287	8.4	56.3	289	17.6	60.3	82	9.6	47.6
2.00 to 2.24	1,369	23.1	45.0	642	18.7	47.9	507	30.9	42.7	220	25.7	38.0
2.25 to 2.49	671	11.3	21.9	477	13.9	29.2	157	9.6	11.8	37	4.3	12.3
2.50 to 2.74	349	5.9	10.6	273	8.0	15.3	27	1.7	2.2	49	5.7	8.0
2.75 to 2.99	161	2.7	4.7	154	4.5	7.3	4	0.2	0.5	3	0.4	2.3
3.00 to 3.24	105	1.8	2.0	88	2.6	2.8	3	0.2	0.3	14	1.6	1.9
3.25 to 3.49	4	0.1	0.2	3	0.1	0.2	1	0.1	0.1			0.3
3.50 to 3.74	4	0.1	0.1	2	0.1	0.1				2	0.2	0.3
3.75 to 3.99			(1)									0.1
4.00 to 4.24			(1)									0.1
4.25 and over	1	(1)	(1)							1	0.1	0.1

[1] Less than one-tenth of 1 per cent.

In the above table separate statistics are presented for Pennsylvania and Vermont only. These two states gave employment to 5,065 wage-earners, or 85.6 per cent of the total number employed in slate quarries in the United States. On the whole, there was comparatively little difference between the rates of pay in the two states. The range of wages for the bulk of employees was greater in Pennsylvania than in Vermont. In the latter state 76.3 per cent of the wage-earners received between $1.50 and $2.24 per day, while in Pennsylvania only 42.1 per cent were included within those rates. In Pennsylvania, on the other hand, there were 28.7 per cent receiving less than $1.50, as compared with 11.9 per cent in Vermont, and 29.2 per cent receiving $2.25 or over, as compared with 11.8 per cent in Vermont.

The 855 wage-earners reported under "all other states" were scattered through 7 states, the number reported in the individual states being too small to warrant separate presentation. It will be seen, however, that taking these states as a group the rates of pay were lower than those for either Pennsylvania or Vermont.

Supplies, materials, and miscellaneous expenses.—The total amount expended for supplies and materials was $680,361; of this amount Pennsylvania reported 61.4 per cent; Vermont, 23.9 per cent; Maine, 4 per cent; Virginia, 3.1 per cent; Maryland, 2.6 per cent; New York, 2.4 per cent; and all other states 2.6 per cent.

Of the total miscellaneous expenses $269,267, or 60.4 per cent was paid for royalties and rent of quarrying plants, and $176,878, or 39.6 per cent, for rent of offices, taxes, and other sundries.

Mechanical power.—The total horsepower reported was 25,454; of this amount 24,649, or 96.8 per cent, was applied through 599 steam engines; 425, or 1.7 per cent, was furnished by 5 water wheels; 185, or seven-tenths of 1 per cent by other mechanism; and 195, or eight-tenths of 1 per cent, was rented electric power.

Production.—In the following table the annual production of slate is classified by uses for the years from 1890 to 1902:

TABLE 36.—*Value of annual production of slate, classified by uses: 1890 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	PRODUCT			
	Total value.	Roofing slate		Mill stock
		Number of squares.	Value.	Value.
1890	$3,482,513	856,625	$2,797,904	$684,609
1891	3,825,746	893,312	3,125,410	700,336
1892	4,117,125	953,000	3,396,625	720,500
1893	2,523,173	621,969	2,209,049	314,124
1894	2,790,324	738,222	2,301,138	489,186
1895	2,698,700	729,927	2,351,509	347,191
1896	2,746,205	673,304	2,263,748	482,457
1897	3,524,614	1,002,118	3,097,452	427,162
1898	3,723,540	916,259	3,129,390	594,150
1899	3,962,733	1,100,513	3,454,817	507,916
1900	4,240,466	1,191,018	3,596,182	644,284
1901	4,787,525	1,304,379	4,114,410	673,115
1902	5,696,051	1,435,168	4,950,428	745,623

The year of greatest depression was 1893, when the value of the product was $2,523,173. There was an increase in 1894, but a slight decrease in 1895. A gradual increase followed from that time until 1902, when the value of all slate produced was $5,696,051. Of this output material to the value of $4,950,428 was utilized for roofing, and the remainder, to the value of $745,623, for minor purposes. It is worthy of note that in 1890 the value of the slate utilized for roofing purposes was $2,797,904, and that for all other purposes, $684,609. This indicates that no important new uses for slate have been found and that developments have been largely in the line of roofing materials.

Ranked by value of product first place was held by Pennsylvania, second by Vermont, and third by Maine, followed by Virginia, New York, and Maryland in the order named.

Table 43, at the end of this report, presents detailed statistics of the industry for 1902.

Occurrence.—Nearly the entire commercial supply of roofing slates comes from states bordering upon the Appalachian mountain system. The prevailing color of the material is of a blue-gray to nearly black tint, though certain of the Vermont quarries produce a green and purplish slate. The supply of red slate is at present limited wholly to a few quarries in eastern New York.

Except in California, there have been during the past ten years no developments of great significance, long established quarries in the states mentioned still furnishing the major part of the material. The quarries in Maine are situated wholly in Piscataquis county, those in Vermont along the western part of the state, bordering on the New York line, the developments of particular note being in the towns of Castleton, Fair Haven, Pawlet, Poultney, and Wells. In New York they are found in the closely adjacent towns of Granville and Middle Granville and other towns in Washington county. The slates of New Jersey occur in Sussex and Warren counties; in Pennsylvania, particularly in Lehigh, Northampton, and York counties. The Maryland output is still derived wholly from the northern part of Harford county, in the well known Peach Bottom area.

Uses.—The slates are utilized to a very large extent for the production of roofing materials, for which purpose they are split into sheets from one-eighth to three-sixteenths of an inch in thickness and trimmed into rectangular slabs varying in size from 3 by 7 to 14 by 24 inches. The price of these slabs is usually dependent upon the number required for a "square," that is, a space 10 feet square, or containing an area of 100 square feet. Besides being used for roofing, slates are utilized for billiard tables, mantels, floor tiles, steps, flagging, blackboards, sinks and stationary washtubs, electrical switchboards, and in the manufacture of school slates and pencils. Incidentally it may be mentioned that there has of late years been something of a demand for roof-

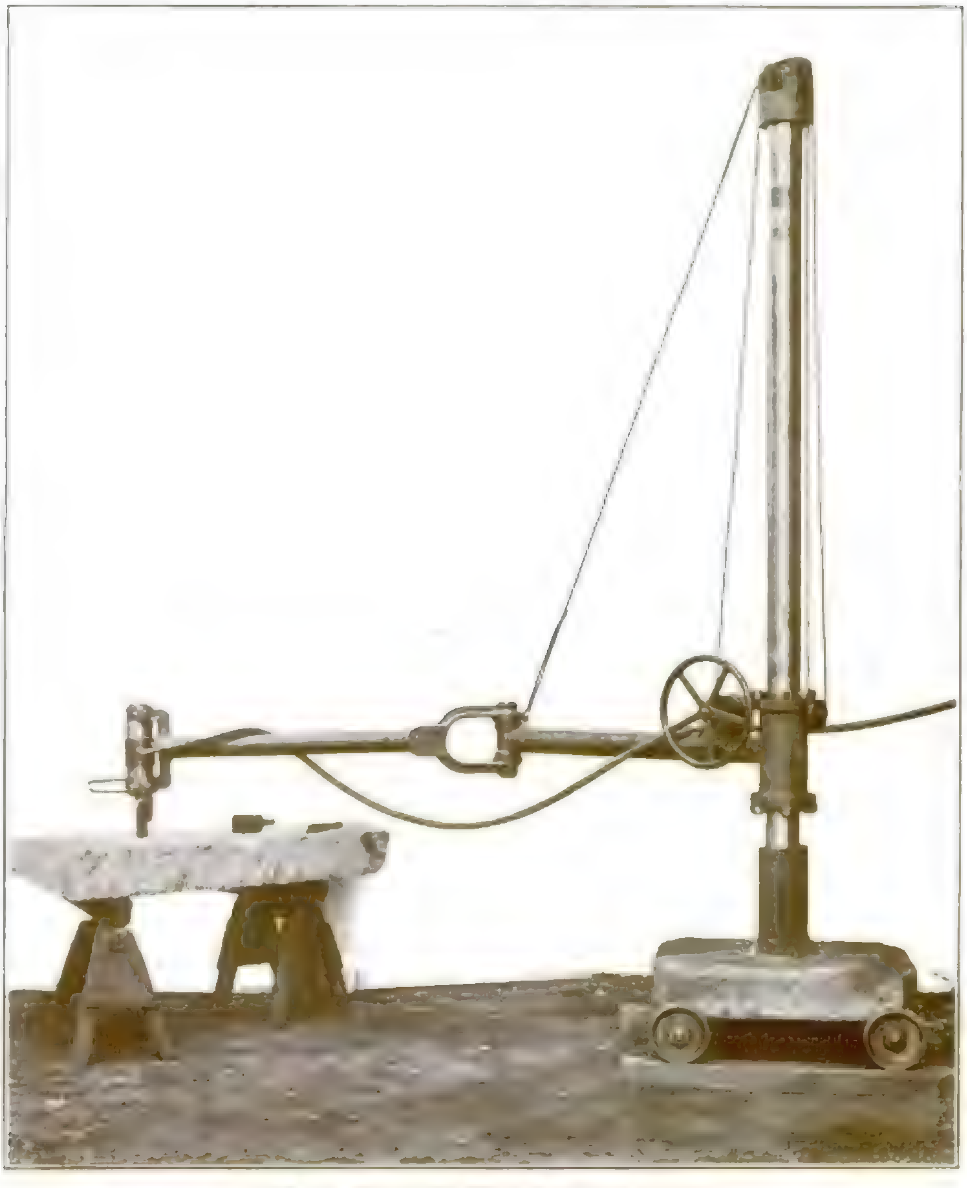

PLATE XIV.—PNEUMATIC STONE SURFACING MACHINE.

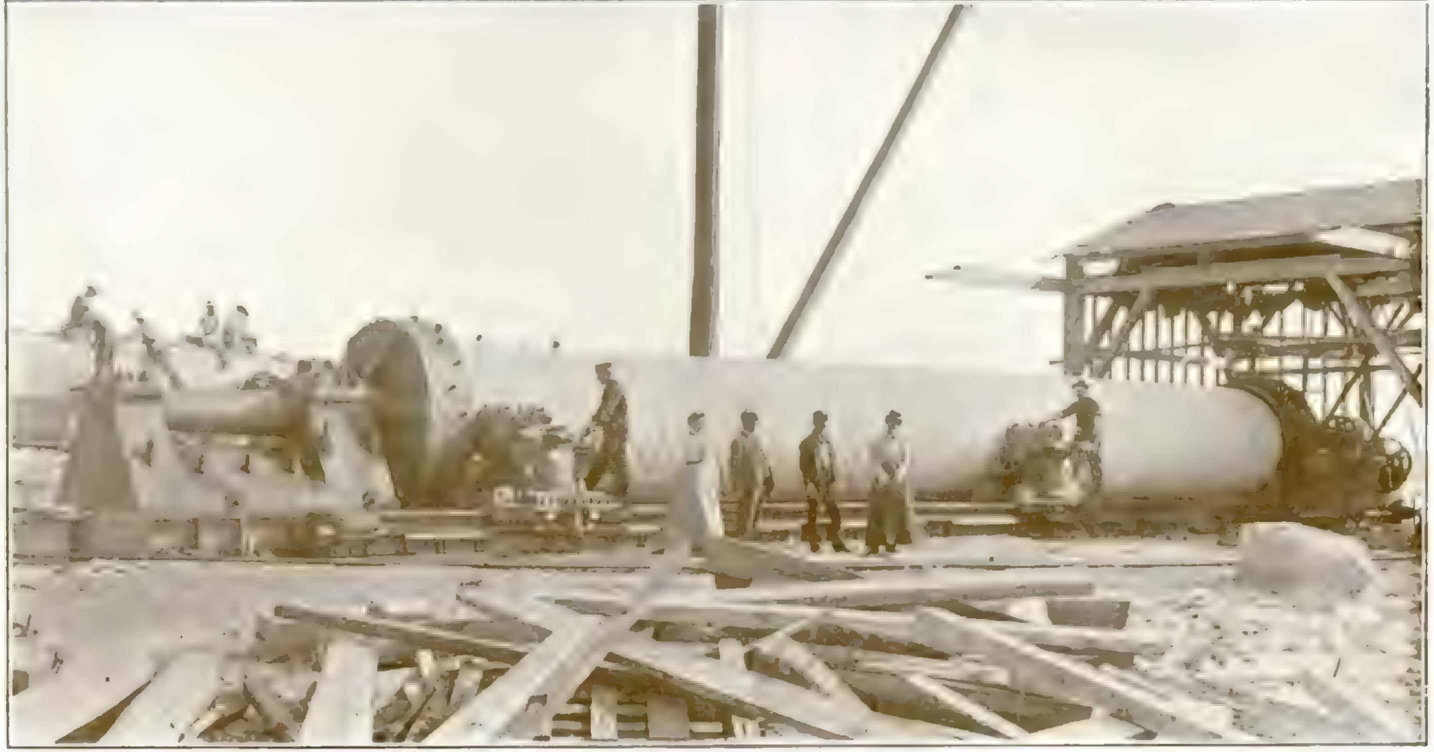

PLATE XV.—LARGE GRANITE COLUMN-CUTTING LATHE AT VINALHAVEN, MAINE.

Weight, 135 tons; swings 6 feet 6 inches by 60 feet in length, with 8 cutters. View of first column being turned in lathe.

ing slates of such thickness as to simulate tiles, some of the quarries actually furnishing material split into sheets of the ordinary sizes, but 1 inch or more in thickness. The practice of "marbleizing" slate for mantels has been largely discontinued.

QUARRYING AND STONE DRESSING MACHINES.

In the earlier days of the stone industry hand methods were employed almost exclusively in the work of quarrying and dressing. The past twenty years has, however, witnessed the introduction of machinery at a rate which is probably fully comparable with that in any other industry. The old method of drilling and blasting, formerly applied to all classes of rocks, is now done away with excepting in the very hardest and toughest of materials, or where, as in the case of the trappean rocks, the material is to be utilized only for road metal. Even where drilling and blasting are now resorted to, it is the custom to drill a series of holes in the line along which it is desired the stone shall break; these holes are then charged somewhat lightly and fired simultaneously. In this way the force of the explosion is delivered along a considerable surface and the danger of shattering the material through the sudden jar is reduced to a minimum. This process is at present largely limited to granitic rocks which are too hard to be quarried by means of the channeling machines.

The drill commonly employed for this work consists in its simplest form of a steam cylinder, mounted upon a tripod, with the drill attached directly to the piston. Since a flexible hose is used to convey steam from the boiler, this form of drill can be carried to any part of the quarry. Numerous adaptations of this drill have been put upon the market by various makers. A common form is that shown in Plate VIII. On soft stone, like sandstone, or granitic rocks with well-developed rift and grain, drills of this kind are utilized in what is known as plug-and-feather splitting. Here a series of holes of a diameter and depth depending upon the character of the rock are drilled at intervals along the line at which it is desired to break the stone. Long metal wedges or plugs are then driven into the holes and the material is split away in fairly regular blocks. This method is used to a considerable extent in the harder Ohio sandstones. During the census year, 3,847 steam drills of various makes were reported as in use.

Channeling machines are utilized in the case of rocks of the nature of marble, limestone, and the softer sandstone, since they would be liable to injury through blasting, and since it is desired to remove the materials from the quarry bed with a minimum amount of waste and in such size and shape that they may be cut into suitable dimensions. One of the earliest of these machines upon the market was the Wardwell channeling machine, a cut of which is shown in Plate IX. Various modifications of this have since been made, as shown in Plates X, XI, and XII. These later adaptations make it possible to cut a channel at any desired angle. There were 724 of these machines of various makes reported in use during the census year. What is known as the quarry bar, answering the same purpose as the channeling machine, but without the locomotive attachment, is shown in Plate XIII. A machine based on the same principle for undercutting, or gadding, is in common use in the marble quarries of Vermont. A diamond drill machine is used for similar purposes. There were 153 machines of various makes adapted to this work reported in operation during the census year.

An attempt has been made to introduce the so-called helicoidal saw for quarrying the softer rocks, as limestone and marble. The attempt seems to have been only partially successful, except in the larger limestone quarries of the Middle West, owing apparently to the large amount of labor necessary for putting the saw in position and the waste involved in cutting out the corners in which the pulleys are to run. The returns from all the quarries report only 32 of these saws actually in use. The saw, as is well known, consists of a twisted iron-wire rope, generally three-sixteenths of an inch in diameter, running over sliding pulleys, the abrading material being either sand or chilled iron, as the case may be.

After the stone is removed from the quarry bed it is worked into the desired shape and size by a process dependent largely upon the hardness of the stone. Formerly a block after being reduced to an approximately rectangular form by means of hand plug-and-feather splitting, was still further reduced by pitching tools, followed when necessary by such implements as the point, ax, pean hammer, and bushhammer. Pneumatic tools are gradually replacing these hand implements. What is known as the pneumatic surfacing machine is shown in Plate XIV. This and the other machines mentioned below are in use in the stone yards and workshops in towns and cities, as well as at the larger quarries, and statistics as to number are not available. Lathes and planers are utilized very extensively on the softer stones, and in some of the works on hard stones as well. Indeed, the production of cylindrical columns by the old hand method has been almost entirely superseded by the use of lathes similar to those used in turning metals. A monster machine of this type is shown in Plate XV. Specially adapted forms of lathes are also used in turning grindstones at the Ohio sandstone quarries. Planers thus utilized differ so little from those employed in planing metal that they need no special notice here. Attention should, however, be called to the circular planer which is used in working out curved surfaces. Except on the harder stone, like granite and quartzite, saws are extensively used for splitting up material into rectangular masses and slabs where smooth, even surfaces are desired. Those most in use are the old time reciprocating saws consisting of a band of soft iron set in a frame and fed with sand, chilled iron, or shot, as the case may be. Circular saws are also utilized in some cases. A circular saw with diamond teeth is occasionally employed. In working slate a steel circular saw with teeth similar to that used in sawing lumber is employed. In handling the material in the yards and shops traveling cranes are used much as in iron and steel works.

TABLE 37.—DETAILED SUMMARY, BY CLASSES: 1902.

	Total.	Limestones and dolomites.	Marble.	Sandstones and quartzites.	Silica sand.	Siliceous crystalline rocks.	Slate.
Number of quarries	5,764	3,246	85	1,304	24	906	199
Number of operators	5,470	3,137	75	1,211	20	853	174
Character of ownership:							
Individual	3,524	2,282	15	759	5	436	27
Firm	1,129	480	14	324	5	219	87
Incorporated company	754	344	45	119	10	176	60
Other form	63	31	1	9		22	
Salaried officials, clerks, etc.:							
Total number	5,279	2,231	352	847	35	1,377	437
Total salaries	$4,488,339	$1,843,747	$341,021	$713,579	$27,228	$1,227,885	$334,879
General officers—							
Number	699	336	51	101	9	136	66
Salaries	$1,058,095	$509,139	$99,260	$154,521	$10,240	$220,180	$64,755
Superintendents, managers, foremen, surveyors, etc.—							
Number	3,295	1,359	197	531	18	923	267
Salaries	$2,620,861	$1,011,374	$180,783	$408,486	$13,108	$799,195	$207,915
Clerks—							
Number	1,285	536	104	215	8	318	104
Salaries	$809,383	$323,234	$60,978	$150,572	$3,880	$208,510	$62,209
Wage-earners:							
Total average number	71,156	31,547	4,070	10,448	335	18,836	5,920
Total wages	$37,515,907	$14,750,638	$2,212,640	$6,153,060	$149,114	$11,072,996	$3,177,459
Engineers, firemen, and other mechanics—							
Average number	6,449	2,233	427	1,248	32	1,916	593
Wages	$4,018,840	$1,354,053	$295,524	$779,149	$18,140	$1,300,178	$271,796
Quarrymen and stonecutters—							
Average number	49,945	22,036	2,513	7,117	149	14,474	3,656
Wages	$26,975,670	$10,250,034	$1,418,332	$4,420,075	$66,074	$8,665,190	$2,155,965
Boys under 16 years—							
Average number	731	258	22	76		206	169
Wages	$160,340	$56,804	$3,756	$17,142		$46,434	$36,204
All other wage-earners—							
Average number	14,031	7,020	1,108	2,007	154	2,240	1,502
Wages	$6,361,057	$3,089,747	$495,028	$936,694	$64,900	$1,061,194	$713,494
Average number of wage-earners at specified daily rates of pay:							
Engineers—							
Less than $0.50							
$0.50 to $0.74	5		1	3		1	
$0.75 to $0.99	10			3		5	2
$1.00 to $1.24	68	17	8	12		11	20
$1.25 to $1.49	193	57	25	12	1	17	81
$1.50 to $1.74	333	166	12	50	4	53	48
$1.75 to $1.99	279	113	7	31	1	89	38
$2.00 to $2.24	853	288	30	236	13	225	61
$2.25 to $2.49	274	119	6	46		96	7
$2.50 to $2.74	295	101	15	68	2	93	16
$2.75 to $2.99	89	45	1	22		20	1
$3.00 to $3.24	106	25	6	34		37	4
$3.25 to $3.49	15	4		7		3	1
$3.50 to $3.74	9	2		3		4	
$3.75 to $3.99	5		1			4	
$4.00 to $4.24	4	1	1	2			
$4.25 and over	2	2					
Firemen—							
Less than $0.50							
$0.50 to $0.74	4	1				3	
$0.75 to $0.99	13	1	4	1		7	
$1.00 to $1.24	45	13	20	2		6	4
$1.25 to $1.49	114	68	4	13		18	11
$1.50 to $1.74	218	130	13	18	3	25	29
$1.75 to $1.99	322	83	10	178		33	18
$2.00 to $2.24	111	35	11	20		32	13
$2.25 to $2.49	33	10	5	4		9	5
$2.50 to $2.74	43	12		3		23	5
$2.75 to $2.99	11	4	1	1		4	1
$3.00 to $3.24	6	1	3			2	
$3.25 to $3.49	3					2	1
$3.50 to $3.74							
$3.75 to $3.99							
$4.00 to $4.24	1			1			
$4.25 and over							
Machinists, blacksmiths, carpenters, and other mechanics—							
Less than $0.50							
$0.50 to $0.74	2			1		1	
$0.75 to $0.99	18	2	1	6		9	
$1.00 to $1.24	55	25	2	10		18	
$1.25 to $1.49	216	77	88	20		25	6
$1.50 to $1.74	334	159	50	34	1	73	17
$1.75 to $1.99	383	110	22	142	2	85	22
$2.00 to $2.24	570	207	34	99	1	190	39
$2.25 to $2.49	395	147	78	36		107	27
$2.50 to $2.74	369	96	23	51	1	185	13
$2.75 to $2.99	273	72	2	24		172	3
$3.00 to $3.24	238	24	7	44		158	5
$3.25 to $3.49	60	3	4	13		38	2
$3.50 to $3.74	39	9	10	3		15	2
$3.75 to $3.99	4		1	3			
$4.00 to $4.24	16	3	2	2		9	
$4.25 and over	2	1					1

TABLE 37.—DETAILED SUMMARY, BY CLASSES: 1902—Continued.

	Total.	Limestones and dolomites.	Marble.	Sandstones and quartzites.	Silica sand.	Siliceous crystalline rocks.	Slate.
Average number of wage-earners at specified daily rates of pay—Continued.							
Quarrymen and stonecutters—							
Less than $0.50							
$0.50 to $0.74	100	35	1	9		52	3
$0.75 to $0.99	606	215	12	20	2	350	7
$1.00 to $1.24	4,774	3,106	468	125		958	117
$1.25 to $1.49	8,463	5,430	585	597	73	1,592	185
$1.50 to $1.74	11,528	6,232	438	1,569	41	2,655	588
$1.75 to $1.99	8,500	4,012	146	1,177	13	2,648	504
$2.00 to $2.24	6,416	1,631	150	1,697	20	1,758	1,160
$2.25 to $2.49	1,976	578	35	328		435	600
$2.50 to $2.74	1,886	317	199	293		814	263
$2.75 to $2.99	1,723	46	141	211		1,163	162
$3.00 to $3.24	2,230	111	112	573		1,348	86
$3.25 to $3.49	701	105	78	90		428	
$3.50 to $3.74	632	106	47	304		175	
$3.75 to $3.99	43		2	23		18	
$4.00 to $4.24	254	59	4	81		110	
$4.25 and over	135	1	95	30		9	
Boys under 16 years—							
Less than $0.50	69	26	6	4		26	7
$0.50 to $0.74	257	95	14	26		56	66
$0.75 to $0.99	243	84		21		63	75
$1.00 to $1.24	157	60		18		50	29
$1.25 to $1.49	11	3		2		5	1
$1.50 to $1.74	3		2			1	
$1.75 to $1.99	1			1			
All other wage-earners—							
Less than $0.50	1					1	
$0.50 to $0.74	90	65	1	1		20	3
$0.75 to $0.99	306	87	44	5		153	17
$1.00 to $1.24	1,449	905	60	125		230	129
$1.25 to $1.49	4,241	2,295	261	561	57	448	609
$1.50 to $1.74	4,898	2,508	343	766	79	739	463
$1.75 to $1.99	1,251	627	92	267	2	190	73
$2.00 to $2.24	1,098	476	68	173	16	269	96
$2.25 to $2.49	237	32	58	70		45	32
$2.50 to $2.74	220	54	57	31		26	52
$2.75 to $2.99	40	6	14	1		5	14
$3.00 to $3.24	132	21	2	3		96	10
$3.25 to $3.49	11	2				9	
$3.50 to $3.74	9	1		1		5	2
$3.75 to $3.99	2	1				1	
$4.00 to $4.24	29	15	8			6	
$4.25 and over	10		10				
Average number of wage-earners employed during each month:							
Men 16 years and over—							
January	49,288	22,481	3,546	5,695	270	12,289	5,109
February	49,658	22,200	3,503	5,766	264	12,695	5,111
March	59,667	27,391	3,855	7,719	335	14,755	5,502
April	71,961	32,808	4,064	10,338	313	18,674	5,764
May	78,240	34,807	4,291	12,673	355	20,138	5,983
June	80,825	35,690	4,165	13,301	341	21,392	5,967
July	82,167	36,130	4,166	13,257	332	22,433	6,126
August	83,050	36,677	4,208	13,041	366	22,602	6,176
September	81,989	36,342	4,409	12,669	380	22,092	6,167
October	79,019	34,667	4,255	11,897	365	21,788	6,047
November	70,132	30,347	4,100	10,428	328	19,147	5,781
December	59,114	26,109	3,921	7,742	331	15,615	5,396
Boys under 16 years—							
January	571	200	28	34		153	156
February	578	204	25	28		163	158
March	662	217	25	46		178	196
April	734	269	26	67		208	164
May	789	277	22	105		212	173
June	796	269	19	105		227	176
July	846	294	20	111		245	176
August	837	288	20	111		241	177
September	822	289	21	96		239	177
October	790	280	20	83		231	176
November	721	257	19	78		201	166
December	626	222	19	48		174	163
Contract work:							
Amount paid	$36,981	$36,481		$400	$100		
Number of employees	140	137		1	2		
Miscellaneous expenses:							
Total	$3,976,865	$1,440,081	$582,877	$878,780	$18,776	$810,206	$446,145
Royalties and rent of quarrying plant	$1,156,754	$422,633	$65,385	$190,144	$8,373	$194,892	$269,267
Rent of offices, taxes, insurance, interest, and other sundries	$2,820,111	$1,017,388	$517,492	$682,636	$10,403	$615,314	$176,878
Cost of supplies and materials	$10,739,736	$5,403,912	$825,822	$1,298,190	$18,386	$2,493,065	$680,361
Value of product:							
Total	$70,462,438	$30,441,801	$5,044,182	$10,601,171	$421,289	$18,257,944	$5,696,051
Rough—							
Building	$5,294,318			$3,119,236		$2,175,082	
Monumental	$1,714,156					$1,714,156	
Other uses	[1]$2,820,543		[1]$2,276,629			$543,914	
Dressed—							
Building	$14,319,184	$5,563,081	$1,008,102	$2,888,218		$4,859,750	
Interior decoration	$679,913		$679,913				
Monumental	$3,211,625		$926,870			$2,284,755	
Ornamental	$7,390		$7,390				
Other uses	$85,368		$85,368				
Crushed—							
Concrete	$2,661,692	$1,600,664		$326,467		$734,561	
Railroad ballast, etc	$3,583,730	$2,661,081		$347,869		$574,780	
Roadmaking, macadam, etc	$5,235,537	$2,890,985		$442,113		$1,902,439	

[1] Includes marble valued at $2,276,629 which was sold in the rough for all purposes.

TABLE 37.—DETAILED SUMMARY, BY CLASSES: 1902—Continued.

	Total.	Limestones and dolomites.	Marble.	Sandstones and quartzites.	Silica sand.	Siliceous crystalline rocks.	Slate.
Value of product—Continued.							
Blast furnace flux	$5,271,232	$5,271,232					
Curbing	$1,828,168	$331,968		$672,654		$823,546	
Flagging	$1,437,267	$241,688		$1,142,699		$52,880	
Ganister	$112,000			$112,000			
Lime burned	$9,335,618	$9,335,618					
Paving blocks	$2,051,393			$527,617		$1,523,776	
Riprap	$1,096,581	$508,177		$269,269		$319,135	
Rubble	$2,242,521	$1,096,729		$645,619		$500,173	
Sand—							
Building	$24,000				$24,000		
Engine	$3,000				$3,000		
Furnace	$78,241				$78,241		
Glass	$130,263				$130,263		
Other uses	$185,782				$185,782		
Slate—							
Roofing	$4,950,128						$4,950,128
Other uses	$745,623						$745,623
Sold to cement manufacturers	$210,798	$210,798					
Sold to lime burners	$237,393	$237,393					
Other uses	$847,835	$492,384		$106,780		$248,671	
Power.							
Total horsepower	178,878	64,900	14,286	25,662	2,000	46,586	25,454
Owned—							
Engines—							
Steam—							
Number	4,173	1,709	131	789	5	940	599
Horsepower	167,744	61,547	10,748	24,631	1,980	44,189	24,649
Gas or gasoline—							
Number	92	59		7		26	
Horsepower	1,378	1,031		72		275	
Water wheels—							
Number	46	15	5	6		15	5
Horsepower	6,731	902	3,413	885		1,106	425
Other power—							
Number	59	25	2	8	1	19	4
Horsepower	2,124	1,221	125	63	20	510	185
Rented—							
Electric, horsepower	775	102		7		471	195
Other power, horsepower	136	97		4		35	
Electric motors owned—							
Number	97	35	32	6		23	1
Horsepower	3,521	769	2,220	60		442	30
Supplied to other establishments, horsepower	28	3				25	

TABLE 38.—LIMESTONES AND DOLOMITES—DETAILED

		United States.	Alabama.	Arkansas.	California.	Colorado.	Connecticut.	Florida.
1	Number of quarries	3,246	33	13	17	11	12	6
2	Number of operators	3,137	29	12	14	9	7	6
	Character of ownership:							
3	Individual	2,282	12	5	5	5	2	4
4	Firm	480	4	4	5		4	2
5	Incorporated company	344	13	3	4	4	1	
6	Other form	31						
	Salaried officials, clerks, etc.:							
7	Total number	2,231	63	16	7	6	18	3
8	Total salaries	$1,843,747	$54,597	$7,864	$9,400	$6,566	$18,830	$2,410
	General officers—							
9	Number	336	11				4	
10	Salaries	$509,139	$17,000				$11,500	
	Superintendents, managers, foremen, surveyors, etc.—							
11	Number	1,359	34	13	7	5	9	3
12	Salaries	$1,011,374	$25,347	$6,784	$9,400	$5,666	$4,370	$2,410
	Clerks—							
13	Number	536	18	3		1	5	
14	Salaries	$323,234	$12,250	$1,080		$900	$2,960	
	Wage-earners:							
15	Total average number	31,547	1,002	119	281	188	135	87
16	Total wages	$14,750,638	$354,718	$43,680	$163,130	$127,747	$66,765	$28,054
	Engineers, firemen, and other mechanics—							
17	Average number	2,233	90	6	2	3	6	6
18	Wages	$1,354,053	$42,969	$2,591	$1,629	$2,625	$3,550	$3,008
	Quarrymen and stonecutters—							
19	Average number	22,036	552	83	184	157	66	64
20	Wages	$10,250,034	$191,949	$29,987	$101,253	$110,052	$31,120	$18,756
	Boys under 16 years—							
21	Average number	258	23	1		2		
22	Wages	$56,804	$3,716	$150		$740		
	All other wage-earners—							
23	Average number	7,020	337	29	95	26	63	17
24	Wages	$3,089,747	$116,184	$10,952	$60,248	$14,330	$32,095	$6,290
	Average number of wage-earners at specified daily rates of pay:							
	Engineers—							
25	$1.00 to $1.24	17						1
26	$1.25 to $1.49	57	3	5				
27	$1.50 to $1.74	166	21	1				
28	$1.75 to $1.99	113						1
29	$2.00 to $2.24	298	1				3	1
30	$2.25 to $2.49	119						
31	$2.50 to $2.74	101						
32	$2.75 to $2.99	45	1			1		
33	$3.00 to $3.24	25						
34	$3.25 to $3.49	4						
35	$3.50 to $3.74	2						
36	$4.00 to $4.24	1						
37	$4.25 and over	2						
	Firemen—							
38	$0.50 to $0.74	1						
39	$0.75 to $0.99	1						
40	$1.00 to $1.24	13	3					
41	$1.25 to $1.49	68	13					
42	$1.50 to $1.74	130	3					
43	$1.75 to $1.99	83						1
44	$2.00 to $2.24	35						
45	$2.25 to $2.49	10						
46	$2.50 to $2.74	12						
47	$2.75 to $2.99	4						
48	$3.00 to $3.24	1						
	Machinists, blacksmiths, carpenters, and other mechanics—							
49	$0.75 to $0.99	2						
50	$1.00 to $1.24	25	5					1
51	$1.25 to $1.49	77	5					
52	$1.50 to $1.74	159	18					
53	$1.75 to $1.99	110	3				1	
54	$2.00 to $2.24	207	9		1		2	
55	$2.25 to $2.49	147	2					
56	$2.50 to $2.74	96	1		1	1		1
57	$2.75 to $2.99	72						
58	$3.00 to $3.24	21	2			1		
59	$3.25 to $3.49	3						
60	$3.50 to $3.74	9						
61	$4.00 to $4.24	3						
62	$4.25 and over	1						
	Quarrymen and stonecutters—							
63	$0.50 to $0.74	35	5					
64	$0.75 to $0.99	215	18					27
65	$1.00 to $1.24	3,106	319	55				34
66	$1.25 to $1.49	5,450	194	6	81			1
67	$1.50 to $1.74	6,232	4	20			61	
68	$1.75 to $1.99	4,011	11		14	60	3	
69	$2.00 to $2.24	1,631		2	62	23	1	1
70	$2.25 to $2.49	578			5	24		
71	$2.50 to $2.74	317			22	16	1	
72	$2.75 to $2.99	66						1
73	$3.00 to $3.24	144				21		
74	$3.25 to $3.49	105						
75	$3.50 to $3.74	106	1			13		
76	$4.00 to $4.24	39						
77	$4.25 and over	1						
	Boys under 16 years—							
78	Less than $0.50	16	1					
79	$0.50 to $0.74	95	20	1				
80	$0.75 to $0.99	84	2					
81	$1.00 to $1.24	60				2		
82	$1.25 to $1.49	3						

SUMMARY, BY STATES AND TERRITORIES: 1902.

Georgia.	Idaho.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Maine.	Maryland.	Massachusetts.	Michigan.	Minnesota.	Missouri.	
8	14	160	160	244	115	70	11	102	11	30	75	142	1
8	13	150	156	241	115	69	11	100	8	29	74	136	2
4	6	85	90	197	88	37	2	84	2	19	54	74	3
1	5	23	38	81	19	12	5	6	4	2	14	29	4
3		35	38	8	8	15	4	9	2	8	3	31	5
		7		5		5		1			3	2	6
15		284	266	76	32	68	16	53	17	62	83	155	7
$6,752		$270,025	$238,186	$46,775	$20,011	$48,405	$13,236	$31,289	$12,606	$49,264	$80,219	$129,291	8
1		66	86	7	6	5	1	12	1	15	11	24	9
$1,260		$88,535	$70,260	$8,150	$3,300	$9,700	$1,000	$11,250	$413	$17,083	$23,800	$37,610	10
11		158	155	58	18	58	14	25	15	32	49	93	11
$4,352		$123,390	$120,663	$34,011	$13,311	$36,530	$11,876	$12,390	$11,293	$23,195	$43,037	$66,514	12
3		80	75	11	8	5	1	16	1	15	23	38	13
$1,140		$58,160	$47,263	$4,614	$3,340	$2,175	$300	$7,649	$900	$8,996	$13,392	$25,167	14
152	6	3,178	2,834	690	566	774	591	490	203	695	725	1,434	15
$42,516	$3,964	$1,737,363	$1,399,829	$357,249	$288,347	$319,700	$288,512	$150,796	$99,740	$325,370	$148,501	$762,178	16
6		277	435	35	25	71	23	33	9	62	65	113	17
$2,274		$191,051	$250,840	$20,198	$17,379	$38,926	$14,454	$14,274	$5,129	$37,367	$45,543	$69,422	18
100	6	2,248	1,967	547	461	637	213	284	87	446	518	880	19
$30,171	$3,964	$1,232,175	$953,593	$288,555	$235,410	$258,132	$119,752	$105,332	$41,287	$217,079	$522,657	$477,756	20
3		13	51	9		6		11		2	4	10	21
$324		$2,943	$42,757	$2,411		$1,155		$1,928		$600	$1,015	$2,551	22
34		640	381	90	80	60	355	102	107	155	136	431	23
$9,747		$311,194	$172,689	$46,065	$35,558	$21,487	$154,300	$38,259	$53,524	$70,333	$79,286	$202,419	24
1		2						2					25
1		1	8			2		11					26
		3	22	2		5		2	3	1		6	27
		7	27	2	1	4			1	1	1	4	28
		47	59	14	6	12	9	3	1	13	1	17	29
		28	20	2	3		2			3	10	9	30
		33	10	1	1	1		1	1		17	12	31
		8	3								8	5	32
		5	1		2						1	3	33
		2											34
		1										1	35
		1											36
		1	1										37
													38
													39
								1					40
			15			4						9	41
		10	48	5		3			1	2		7	42
		16	6	1			4			17	1	2	43
		9	6				5			1		3	44
		3											45
		2	1									1	46
											2	2	47
				1									48
													49
3						4		2			1		50
			3			3		8				5	51
1		11	24	1		7		1			2	8	52
		6	37	2		6				1	2	6	53
		16	27	4	6	12	2	2		21	14	5	54
		23	63		2	2			2		1	1	55
		16	16		1	6	1			1	7	6	56
		20	27							1		1	57
		5	2		3						2		58
			2										59
		1	4										60
			2										61
			1										62
						1		1					63
54		1	7			2						1	64
61		5	44	10	3	220		143		10	1	12	65
4		44	716	7	59	245		84		3	1	147	66
	1	612	708	148	214	102	39	83	70	330	24	163	67
		1,157	143	231	112	10	150		13	40	275	204	68
	2	389	100	107	12	21	24			55	79	181	69
	2	10	73	18	16	5					28	82	70
	1	1	48	19	1	9		1		8	56	61	71
			17		2	16						13	72
		3	18	5	6	5		1	4		25	10	73
		12	9					1			24		74
		3	16	1	14	1						6	75
		11	7	1	1						5		76
			1										77
3		1	1										78
		4	12	1		3		9			2	3	79
		7	20	4		3					1	2	80
		1	17	4				2		2		5	81
			1								1		82

TABLE 38.—LIMESTONES AND DOLOMITES—DETAILED

		United States.	Alabama.	Arkansas.	California.	Colorado.	Connecticut.	Florida.
	Average number of wage earners at specified daily rates of pay—Continued.							
	All other wage-earners—							
83	$0.50 to $0.74	65	8					
84	$0.75 to $0.99	87	10					
85	$1.00 to $1.24	966	219	10				10
86	$1.25 to $1.49	2,215	39	12			1	1
87	$1.50 to $1.74	[illegible]	33	6	8	8	37	6
88	$1.75 to $1.99	627	9			15	21	
89	$2.00 to $2.24	476	12		65		1	
90	$2.25 to $2.49	31			2			
91	$2.50 to $2.74	54		1	26	3		
92	$2.75 to $2.99	6						
93	$3.00 to $3.24	24						
94	$3.25 to $3.49	2						
95	$3.50 to $3.74	1						
96	$3.75 to $3.99	1						
97	$4.00 to $4.24	[illegible]						
	Average number of wage-earners employed during each month:							
	Men 16 years and over—							
98	January	22,481	899	127	264	186	102	104
99	February	22,210	917	112	264	186	102	106
100	March	27,091	948	121	272	185	150	100
101	April	32,868	979	122	282	185	114	102
102	May	34,867	988	143	286	184	224	63
103	June	35,020	1,000	128	289	187	113	62
104	July	36,151	967	96	290	188	166	61
105	August	36,677	1,009	135	290	188	158	61
106	September	36,322	1,015	154	290	187	163	60
107	October	34,067	1,012	107	286	186	162	109
108	November	30,447	1,007	108	285	186	165	105
109	December	26,069	978	92	273	186	162	103
	Boys under 16 years—							
110	January	200	23	1		2		
111	February	204	23	1		2		
112	March	247	23	1		2		
113	April	269	23	1		2		
114	May	277	23	1		2		
115	June	269	23	1		2		
116	July	294	23	1		2		
117	August	288	23	1		2		
118	September	289	23	1		2		
119	October	280	23	1		2		
120	November	247	23	1		2		
121	December	222	23	1		2		
	Contract work:							
122	Amount paid	$36,381			$4,000			
123	Number of employees	137			10			
	Miscellaneous expenses:							
124	Total	$1,440,081	$25,951	$1,716	$15,790	$5,886	$9,028	$2,208
125	Royalties and rent of quarrying plant	$422,693	$2,079		$8,825	$2,907	$1,320	$1,350
126	Rent of offices, taxes, insurance, interest, and other sundries.	$1,017,388	$23,875	$1,716	$6,965	$2,979	$7,708	$858
127	Cost of supplies and materials	$5,443,912	$149,012	$32,579	$111,561	$21,140	$64,346	$11,769
	Value of product:							
128	Total	$30,111,801	$759,617	$113,163	$521,076	$206,700	$205,771	$65,571
129	Building	$5,763,084	$97,758	$1,000	$17,250			$11,000
130	Flagging	$211,688						
131	Curbing	$531,968	$1,275	$1,400	$250			
132	Lime burned	$9,335,618	$235,748	$82,853	$390,180	$16,515	$216,869	$37,563
133	Sold to lime burners	$237,893				$521		
	Crushed—							
134	Concrete	$1,600,461	$2,300		$24,575			
135	Railroad ballast, etc	$2,661,481	$2,300	$7,000	$1,625			$1,350
136	Roadmaking, macadam, etc	$2,880,985	$7,810	$15,510	$900			$9,658
137	Rubble	$1,080,720	$1,735		$5,250			
138	Riprap	$508,175	$5,726	$4,350	$1,880			$5,600
139	Blast furnace flux	$5,251,252	$165,665		$5,250	$175,184	$1,472	
140	Sold to cement manufacturers	$210,798			$21,250			
141	Other uses	$192,381		$50	$11,518	$1,750		
	Power:							
142	Total horsepower	64,500	1,290	50		75	171	8
	Owned—							
	Engines—							
	Steam—							
143	Number	1,703	26	3		1	12	1
144	Horsepower	61,547	1,254	50		75	169	8
	Gas or gasoline—							
145	Number	70					1	
146	Horsepower	1,031					2	
	Water wheels—							
147	Number	25						
148	Horsepower	702						
	Other power—							
149	Number	25	1					
150	Horsepower	1,221	10					
	Rented—							
151	Electric, horsepower	292						
152	Other kinds, horsepower	57						
	Electric motors owned—							
153	Number	35						
154	Horsepower	769						
155	Supplied to other establishments, horsepower	3						

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Georgia.	Idaho.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Maine.	Maryland.	Massachusetts.	Michigan.	Minnesota.	Missouri.	
			1			1		2			1		83
17		1	2			8		1				11	84
17		7	24		26	6	20	62	2	6		4	85
		77	146	1	3	40	210	26		2	1	175	86
		360	129	49	24	3	80		88	131	15	139	87
		183	33	16	14	2	20		25	9	7	48	88
		12	39	11	12		24		5	3	106	31	89
							1			1		4	90
			4		1			11				5	91
													92
			4	3							3	1	93
													94
											4		95
													96
												13	97
159	2	2,082	1,651	381	254	319	329	347	162	550	337	866	98
155	2	2,074	1,676	359	278	329	328	368	158	584	292	897	99
151		2,845	2,545	565	186	572	362	512	170	571	450	1,298	100
166	4	3,375	3,156	729	601	787	601	606	202	678	770	1,418	101
172	6	3,499	3,388	803	673	895	602	667	214	712	935	1,497	102
170	13	3,560	3,379	818	639	914	916	371	212	719	949	1,546	103
146	11	3,600	3,471	807	746	1,065	928	347	223	731	909	1,545	104
120	11	3,698	3,279	830	741	1,163	916	392	234	758	978	1,684	105
137	9	3,715	3,350	898	743	1,130	901	394	237	783	936	1,744	106
128	7	3,627	3,137	863	663	849	400	434	214	729	889	1,742	107
152	5	3,263	2,534	635	545	680	375	392	214	665	650	1,556	108
139	2	2,652	1,880	424	370	510	346	328	207	556	443	1,285	109
3		6	34	7				14		2	1	7	110
3		6	34	6		2		14		2	1	7	111
3		9	46	7		8		16		2	3	10	112
3		12	55	7		8		16		2	4	11	113
3		14	57	9		7		16		2	5	12	114
3		15	60	9		7		2		2	6	12	115
3		17	66	10		9		2		2	6	12	116
3		17	58	12		7		5		2	6	11	117
3		17	64	15		7		5		2	6	10	118
3		16	55	12		7		16		2	5	10	119
3		17	47	8		7		17		2	3	11	120
3		12	48	6		3		14		2	1	7	121
				$60	$300	$500					$1,000	$14,595	122
				2	6	8					3	61	123
$3,348	$110	$283,379	$190,907	$22,518	$21,378	$14,143	$37,613	$20,841	$10,192	$36,463	$46,880	$51,506	124
$2,527		$86,439	$17,273	$6,108	$11,089	$6,461	$5,248	$6,363	$112	$300	$21,241	$17,952	125
$821	$110	$196,940	$173,634	$16,410	$10,289	$7,682	$32,365	$14,478	$10,080	$36,164	$25,639	$33,554	126
$17,905	$1,265	$551,908	$490,764	$71,361	$51,312	$51,809	$226,691	$135,540	$133,609	$80,659	$84,294	$262,222	127
$111,589	$15,074	$3,232,123	$2,855,636	$649,984	$670,539	$733,747	$745,132	$185,000	$699,349	$657,072	$838,357	$1,697,139	128
$4,295		$640,147	$1,818,577	$191,409	$176,374	$121,167		$16,353	$12,378	$58,707	$451,368	$420,115	129
$17,500		$70,131	$75,692	$6,893	$7,315	$1,398				$300	$25,481	$562	130
		$30,290	$117,167	$2,374	$5,650	$45,773		$1,575		$180	$7,200	$32,444	131
$71,724	$13,049	$485,644	$312,189	$114,061	$7,358	$15,898	$745,132	$520,177	$624,488	$208,232	$73,870	$515,780	132
				$95				$5,851		$98,000	$1,344		133
		$252,139	$88,763	$29,000	$10,180	$26,197		$1,000	$1,000	$40,180	$62,500	$168,220	134
$12,310		$399,555	$56,710	$21,298	$254,721	$176,032		$17,361		$40,810		$141,180	135
		$588,796	$180,188	$103,074	$28,508	$125,048		$71,265		$56,261	$95,711	$256,827	136
		$353,669	$37,916	$144,330	$79,769					$3,101	$100,665	$147,161	137
		$154,624	$15,346	$32,588	$9,252	$22,500		$22		$5,700	$55,447	$14,558	138
$5,700	$2,025	$211,883	$187,265			$15,487	$1,000	$3,253	$1,308	$32,246		$11,065	139
		$9,515								$55,692	$7,501		140
		$12,758	$32,171	$1,263	$1,849	$41,105	$2,000	$3,100		$68,164	$1,150	$11,909	141
146		9,282	10,466	1,541	1,006	1,753	714	748	120	1,149	1,345	2,956	142
3		268	297	45	31	4	15	32	8	28	52	109	143
146		9,246	10,103	1,545	1,009	1,743	714	727	120	1,146	1,270	2,766	144
		3	3	3						1	3	8	145
		42	60	18						3	18	110	146
				1									147
				10									148
		5	2					1			2		149
		78	303					10			15		150
												50	151
													152
			7									5	153
			140									80	154
				1									155

TABLE 38.—LIMESTONES AND DOLOMITES—DETAILED

		Montana.	Nebraska.	New Jersey.	New York.	North Carolina.[1]	Ohio.	Oklahoma.
1	Number of quarries	10	33	27	181	4	259	12
2	Number of operators	10	33	22	178	4	249	12
	Character of ownership:							
3	Individual	6	21	17	123	3	171	11
4	Firm	2	9	1	32		47	1
5	Incorporated company	2	3	4	20	1	29	
6	Other form				3		2	
	Salaried officials, clerks, etc.:							
7	Total number	4	12	15	174	1	265	4
8	Total salaries	$4,091	$8,001	$11,301	$166,459	$600	$155,451	$3,035
	General officers—							
9	Number	1		3	27		90	
10	Salaries	$600		$3,700	$53,777		$41,715	
	Superintendents, managers, foremen, surveyors, etc.—							
11	Number	3	10	11	109	1	113	3
12	Salaries	$3,491	$7,001	$7,151	$87,568	$600	$84,192	$2,315
	Clerks—							
13	Number		2	1	38		62	1
14	Salaries		$1,000	$450	$25,114		$29,544	$720
	Wage-earners:							
15	Total average number	91	178	187	2,422	17	3,065	46
16	Total wages	$70,078	$95,935	$80,654	$1,214,712	$4,727	$1,454,328	$22,277
	Engineers, firemen, and other mechanics—							
17	Average number		9	10	206	1	210	2
18	Wages		$5,938	$4,628	$163,926	$540	$131,232	$2,003
	Quarrymen and stonecutters—							
19	Average number	89	127	115	1,346	14	2,246	40
20	Wages	$68,206	$68,715	$51,160	$667,484	$4,087	$1,032,612	$18,960
	Boys under 16 years—							
21	Average number		2		12		8	1
22	Wages		$615		$2,689		$1,801	$105
	All other wage-earners—							
23	Average number	2	40	62	858	2	601	3
24	Wages	$1,872	$20,677	$24,866	$380,613	$100	$288,683	$1,209
	Average number of wage-earners at specified daily rates of pay:							
	Engineers—							
25	$1.00 to $1.24					1		
26	$1.25 to $1.49				2		3	
27	$1.50 to $1.74				11		21	
28	$1.75 to $1.99			1	8		29	
29	$2.00 to $2.24		1		24		28	
30	$2.25 to $2.49		1		9		3	
31	$2.50 to $2.74				8		4	
32	$2.75 to $2.99				1		30	
33	$3.00 to $3.24		1		4		1	1
34	$3.25 to $3.49						1	
35	$3.50 to $3.74							
36	$4.00 to $4.24							
37	$4.25 and over							
	Firemen—							
38	$0.50 to $0.74							
39	$0.75 to $0.99							
40	$1.00 to $1.24				1			
41	$1.25 to $1.49			1	5			
42	$1.50 to $1.74			1	7		29	
43	$1.75 to $1.99			1	9		6	
44	$2.00 to $2.24				3		1	
45	$2.25 to $2.49				2		4	
46	$2.50 to $2.74				1			
47	$2.75 to $2.99							
48	$3.00 to $3.24							
	Machinists, blacksmiths, and other mechanics—							
49	$0.75 to $0.99							
50	$1.00 to $1.24			1				
51	$1.25 to $1.49			4	4		3	
52	$1.50 to $1.74				32		20	
53	$1.75 to $1.99				19		6	
54	$2.00 to $2.24		6	1	17		21	
55	$2.25 to $2.49				14		5	
56	$2.50 to $2.74				13		4	1
57	$2.75 to $2.99				5		10	
58	$3.00 to $3.24				[illegible]		1	
59	$3.25 to $3.49				[illegible]			
60	$3.50 to $3.74				2		1	
61	$4.00 to $4.24							
62	$4.25 and over							
	Quarrymen and stonecutters—							
63	$0.50 to $0.74					3		
64	$0.75 to $0.99				1		3	
65	$1.00 to $1.24	2	4	1	138	11	71	6
66	$1.25 to $1.49			71	112		266	
67	$1.50 to $1.74	4	1	21	587		1,642	29
68	$1.75 to $1.99		117	18	251		175	1
69	$2.00 to $2.24		1	5	120		88	1
70	$2.25 to $2.49	65	4	1	23			
71	$2.50 to $2.74				12		2	1
72	$2.75 to $2.99	2			2		1	
73	$3.00 to $3.24	16			32			
74	$3.25 to $3.49				30		1	
75	$3.50 to $3.74				2			3
76	$4.00 to $4.24				10			
77	$4.25 and over							
	Boys under 16 years—							
78	Less than $0.50				[illegible]			
79	$0.50 to $0.74				[illegible]		2	
80	$0.75 to $0.99		1		6		1	1
81	$1.00 to $1.24		1		2		2	
82	$1.25 to $1.49				2			

[1] Includes operators distributed as follows: Nevada, 1; Rhode Island, 2; South Carolina, 1.

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Oregon.	Pennsylvania.	South Dakota.	Tennessee.	Texas.	Utah.	Vermont.	Virginia	Washington.	West Virginia.	Wisconsin.	Wyoming.	All other states and territories.[1]	
7	907	10	51	35	16	14	37	12	174	216	3	4	1
6	896	10	44	34	15	13	28	12	167	207	3	4	2
1	768	9	25	19	5	11	12	1	157	151	1	3	3
4	90	...	11	13	6	1	6	4	6	33	2	1	4
1	37	1	7	2	4	1	10	7	4	22	...	...	5
...	1	...	1	...	...	...	...	...	...	1	...	...	6
1	287	1	37	30	7	12	63	22	31	82	...	3	7
$1,200	$228,826	$1,278	$27,826	$21,393	$2,295	$7,953	$30,459	$35,701	$27,259	$58,353	...	$1,540	8
...	39	...	5	...	...	3	6	6	2	14	...	...	9
...	$55,025	...	$7,800	...	...	$2,500	$5,800	$15,601	$4,800	$16,900	...	...	10
1	178	1	26	24	3	6	46	11	22	51	...	3	11
$1,200	$129,112	$1,278	$17,426	$17,859	$915	$3,973	$25,323	$15,300	$18,799	$31,852	...	$1,540	12
...	70	...	6	6	4	3	11	5	7	17	...	...	13
...	$44,089	...	$2,600	$3,534	$1,380	$1,480	$4,336	$4,800	$3,660	$9,601	...	...	14
19	6,934	55	698	275	103	156	890	147	1,068	1,062	7	79	15
$10,102	$2,891,295	$43,714	$222,475	$124,272	$77,296	$65,085	$290,979	$87,850	$426,101	$539,169	$5,640	$26,456	16
4	291	1	34	19	3	10	38	12	53	68	...	6	17
$1,948	$159,555	$900	$14,888	$12,707	$2,769	$1,690	$18,817	$8,892	$21,967	$39,280	...	$2,674	18
9	5,104	18	538	192	83	83	607	77	800	944	7	58	19
$5,251	$2,104,138	$39,600	$175,024	$84,156	$62,977	$53,913	$197,021	$49,388	$321,275	$474,194	$5,640	$16,650	20
...	33	...	17	4	...	...	36	...	9	1	...	...	21
...	$9,010	...	$2,557	$1,154	...	...	$6,336	...	$2,037	$210	...	...	22
6	1,516	6	109	60	17	63	269	58	206	49	...	15	23
$2,900	$608,592	$3,214	$90,006	$26,265	$11,580	$26,510	$68,176	$29,570	$78,142	$25,485	...	$7,232	24
...	[illegible]	...	3	...	...	1	...	...	2	...	...	...	25
...	8	...	2	1	...	1	5	...	3	...	...	1	26
1	35	...	2	...	...	2	4	...	14	8	...	1	27
...	12	...	1	...	...	...	2	...	...	10	...	1	28
...	34	...	...	2	...	1	1	1	2	7	...	...	29
...	24	...	...	...	...	...	1	...	...	4	...	...	30
...	4	...	...	1	...	...	1	...	1	5	...	...	31
...	2	...	...	1	...	...	...	...	...	...	...	...	32
...	3	1	...	...	1	...	...	1	...	...	...	...	33
...	...	...	...	...	1	...	...	...	...	...	...	...	34
...	...	...	...	...	...	...	...	...	...	...	...	...	35
...	...	...	...	...	...	...	...	...	...	...	...	...	36
...	...	...	...	...	...	...	...	...	...	...	...	...	37
...	...	...	...	...	...	1	...	...	...	...	...	...	38
...	...	...	...	...	...	...	...	...	...	...	...	1	39
...	...	...	...	...	...	...	8	...	5	...	...	...	40
...	12	...	1	...	...	...	2	...	6	...	...	...	41
...	17	...	1	...	...	...	...	...	1	4	...	...	42
...	10	...	...	6	...	...	...	...	...	3	...	...	43
...	4	...	...	...	...	...	...	...	2	1	...	...	44
...	1	...	...	...	...	...	...	...	...	...	...	...	45
...	...	...	...	...	...	...	...	7	...	...	...	...	46
...	...	...	...	...	...	...	...	...	...	...	...	...	47
...	...	...	...	...	...	...	...	...	...	...	...	...	48
...	...	...	2	...	...	...	...	...	...	...	...	...	49
1	1	...	2	...	...	1	1	...	1	1	...	...	50
...	19	...	10	...	...	1	5	...	6	...	...	1	51
...	13	...	7	1	...	...	5	...	5	3	...	...	52
...	9	...	...	...	...	2	1	...	...	9	...	1	53
...	26	...	2	1	...	...	4	1	2	7	...	...	54
...	31	...	...	1	...	...	...	...	1	1	...	...	55
1	7	...	1	2	1	...	5	1	...	1	...	...	56
...	5	...	...	...	...	...	...	...	2	1	...	...	57
...	...	...	...	2	...	...	...	1	...	...	...	...	58
...	...	...	...	...	...	...	...	...	...	...	...	...	59
...	...	...	...	1	...	...	...	...	...	...	...	...	60
1	...	...	...	...	...	...	...	...	...	...	...	...	61
...	...	...	...	...	...	...	...	...	...	...	...	...	62
...	1	1	4	...	...	...	3	...	1	...	...	15	63
...	36	...	21	...	...	...	7	...	...	3	...	34	64
1	857	...	440	67	1	17	530	...	29	9	3	...	65
1	2,490	...	64	32	...	47	56	...	718	29	...	8	66
...	788	...	1	51	2	11	...	...	4	450	...	1	67
2	502	...	...	15	1	6	...	27	18	307	...	...	68
2	232	...	...	16	33	2	1	19	...	42	3	...	69
3	172	12	...	4	9	...	...	21	...	1	...	...	70
...	1	35	1	...	3	...	8	10	...	2	1	...	71
...	2	...	...	...	...	...	4	...	...	6	...	...	72
...	...	...	...	...	16	...	...	...	...	2	...	...	73
...	...	...	...	...	18	...	...	...	...	1	...	...	74
...	33	...	7	3	...	...	1	...	...	2	...	...	75
...	...	...	...	4	...	...	...	...	...	...	...	...	76
...	...	...	...	...	...	...	...	...	...	...	...	...	77
...	2	...	3	...	...	...	4	...	...	...	...	...	78
...	3	...	12	...	...	...	19	...	...	1	...	...	79
...	7	...	2	2	...	...	13	...	9	...	...	...	80
...	20	...	...	2	...	...	...	...	...	...	...	...	81
...	1	...	...	...	...	...	...	...	...	...	...	...	82

TABLE 38.—LIMESTONES AND DOLOMITES—DETAILED

		Montana.	Nebraska.	New Jersey.	New York.	North Carolina.	Ohio.	Oklahoma.
	Average number of wage-earners at specified daily rates of pay—Continued.							
	All other wage-earners—							
83	$0.50 to $0.74				5	2	1	
84	$0.75 to $0.99				3		5	
85	$1.00 to $1.24			2	34		4	
86	$1.25 to $1.49		1	32	255		128	
87	$1.50 to $1.74		4	2	121		392	3
88	$1.75 to $1.99		34	1	17		25	
89	$2.00 to $2.24			1	65		44	
90	$2.25 to $2.49				15			
91	$2.50 to $2.74			1	3			
92	$2.75 to $2.99				1		1	
93	$3.00 to $3.24	2	1		10			
94	$3.25 to $3.49						1	
95	$3.50 to $3.74							
96	$3.75 to $3.99							
97	$4.00 to $4.24							
	Average number of wage-earners employed during each month:							
	Men 16 years and over—							
98	January	83	55	187	1,347		2,344	34
99	February	83	75	188	1,555	6	2,230	15
100	March	88	128	224	1,806	12	2,682	26
101	April	103	207	235	2,553	6	3,002	68
102	May	97	191	218	2,844	6	3,375	65
103	June	97	233	161	2,934	6	3,611	53
104	July	98	224	193	2,994	30	3,593	51
105	August	98	220	192	3,013	30	3,751	51
106	September	95	225	170	2,969	30	3,576	52
107	October	89	218	161	2,885	30	3,106	57
108	November	83	186	159	2,508	24	2,518	41
109	December	83	150	155	1,722	24	2,596	27
	Boys under 16 years—							
110	January		2		12		4	
111	February		2		12		5	
112	March		2		12		6	
113	April		2		12		7	2
114	May		2		12		9	2
115	June		2		12		9	2
116	July		2		15		11	2
117	August		2		15		11	2
118	September		2		13		9	1
119	October		2		12		10	1
120	November		2		11		8	
121	December		2		6		7	
	Contract work:							
122	Amount paid					$8,000	$7,276	
123	Number of employees					30	16	
	Miscellaneous expenses:							
124	Total	$829	$2,760	$7,833	$142,206	$763	$139,648	$840
125	Royalties and rent of quarrying plant		$823	$3,869	$28,662	$488	$41,223	$200
126	Rent of offices, taxes, insurance, interest, and other sundries.	$829	$1,937	$3,964	$113,544	$275	$98,425	$640
127	Cost of supplies and materials	$8,135	$11,173	$23,044	$451,876	$3,888	$590,462	$6,757
	Value of product:							
128	Total	$101,725	$145,473	$188,650	$2,503,536	$23,153	$3,201,998	$50,511
129	Building	$3,375	$46,910	$4,450	$480,141		$520,808	$22,562
130	Flagging	$1,400	$150		$3,420		$5,601	$7,783
131	Curbing		$85		$857		$4,718	$4,540
132	Lime burned	$8,775	$150	$123,478	$561,228	$2,090	$1,092,277	$25
133	Sold to lime burners		$400		$43,531		$62,218	
	Crushed—							
134	Concrete		$25,182	$580	$302,489		$180,300	
135	Railroad ballast, etc		$12,510		$267,189		$317,281	$9,000
136	Roadmaking, macadam, etc		$15,050		$514,916	$21,063	$454,170	
137	Rubble	$175	$24,114		$95,026		$32,163	$4,570
138	Riprap		$16,515		$5,806		$46,786	
139	Blast furnace flux	$88,000	$4,407	$53,142	$92,849		$630,325	
140	Sold to cement manufacturers			$7,000	$84,415		$1,280	
141	Other uses				$51,669		$56,068	$2,063
	Power:							
142	Total horsepower	75	284	135	6,497	80	8,461	52
	Owned—							
	Engines—							
	Steam—							
143	Number	1	7	4	117	3	217	2
144	Horsepower	15	280	135	6,172	80	7,619	52
	Gas or gasoline—							
145	Number		1		2		17	
146	Horsepower		4		15		118	
	Water wheels—							
147	Number	1			7		3	
148	Horsepower	60			245		12	
	Other power—							
149	Number						4	
150	Horsepower						328	
	Rented—							
151	Electric, horsepower						52	
152	Other power, horsepower				65		32	
	Electric motors owned—							
153	Number				9		1	
154	Horsepower				228		1	
155	Supplied to other establishments, horsepower							

[1] Includes operators distributed as follows: Nevada, 1; Rhode Island, 2; South Carolina, 1.

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Oregon.	Pennsylvania.	South Dakota.	Tennessee.	Texas.	Utah.	Vermont.	Virginia.	Washington.	West Virginia.	Wisconsin.	Wyoming.	All other states and territories.[1]	
	22		21				1						83
	1		26	1						1			84
1	181	1	62			2	175		30				85
	[illegible]	2		28		37	13	8	168	2		9	86
	176			19	2	29		17	1	18			87
	63			7		1		20	7	25			88
5	10	2		4	9			9		1		6	89
	4							1					90
		1			1			3					91
					1								92
				1									93
					1								94
													95
	1												96
										2			97
2	5,721	58	528	141	68	121	790	117	962	657	7	75	98
6	5,688	64	521	164	62	158	737	122	968	666	7	35	99
13	6,296	58	617	215	74	196	878	132	949	523	7	58	100
25	7,152	64	667	290	81	162	918	130	1,161	1,121	7	80	101
32	7,441	48	723	301	83	160	857	136	1,098	1,306	7	90	102
32	7,488	50	741	402	80	173	882	132	1,100	1,362	7	95	103
29	7,191	50	787	391	103	160	901	137	1,076	1,488	7	95	104
30	7,577	32	785	414	118	267	922	140	1,072	1,302	7	95	105
31	7,579	50	769	271	138	171	872	144	1,104	1,242	7	89	106
13	7,165	[illegible]	716	211	151	172	851	161	1,133	1,135	7	95	107
9	6,858	60	685	228	150	166	784	208	1,117	1,024	7	98	108
6	6,528	58	608	230	128	150	886	198	2,07[illegible]	762	7	82	109
	37		17	3			30		8				110
	29		15	3			19		8				111
	50		18	7			47		8				112
	41		18	5			38		2	2			113
	53		16	4			37		10	2			114
	55		16	4			95		9	2			115
	55		17	4			43		20	2			116
	50		18	4			11		9	2			117
	58		18	4			29		10	2			118
	4		18	4			30		9				119
	4		18	4			33		9				120
	2		18	4			32		9				121
					$250								122
					1								123
$120	$250,128	$466	$11,462	$8,158	$4,457	$[illegible]	$24,808	$8,408	$8,144	$47,162	$2	$6,340	124
	$168,747	$26	$5,749	$2,570	$1,080	$2,790	$6,689	$900	$575	$4,650		$4,300	125
$120	$81,381	$540	$5,713	$5,888	$3,377	$3,060	$18,220	$7,506	$7,768	$42,477	$2	$2,040	126
$4,220	$972,615	$[illegible]	$101,136	$54,[illegible]	$74,036	$112,201	$[illegible]	$28,125	$78,[illegible]	$254,150	$225	$36,[illegible]	127
$20,133	$5,158,133	$89,625	$482,[illegible]	$228,[illegible]	$186,063	$225,508	$585,114	$213,814	$606,[illegible]	$1,[illegible]	$6,340	$74,464	128
	$506,[illegible]	$77	$57,309	$69,327	$3,960	$1,500	$41,355		$25	$226,998	$90		129
	$8,972		$180	$6,620					$400	$6,780			130
	$4,502		$3,257	$8,700						$58,241			131
$20,133	$1,[illegible]	$21,900	$235,615	$82,500	$99,363	$219,906	$241,984	$180,070	$182,048	$540,357	$2,250	$72,924	132
	$16,650								$8,700				133
	$348,678	$2,000	$[illegible]	$28,793			$11,880		$2,200	$36,503			134
	$674,211		$56,517	$400			$7,574		$153,098	$29,900		$500	135
	$215,[illegible]		$8,878		$400	$1,587			$1,176	$218,933			136
	$1,410	$180	$8,015	$8,705		$580				$44,293			137
	$12,002		$2,264	$2,325					$105	$39,573			138
	$2,461,138	$54,740	$138,800	$23,452	$82,800	$125	$220,161	$22,250	$298,092	$50,940	$4,000	$1,190	139
	$38,116						$1,000						140
	$89,903		$700	$8,000			$11,318	$5,506		87,442			141
50	9,41[illegible]	50	303	285		224	120	75	1,875	2,777		80	142
1	196	1	22	18		10	16	1	23	63		4	143
50	8,8[illegible]	50	590	285		131	120	8	1,845	2,620		80	144
	11		1					1		4			145
	191		3					15		109			146
	2					1				2			147
	50					70				65			148
	7					1		2	2				149
	310					20		52	30				150
													151
													152
	12					5							153
	302					55							154
													155

TABLE 39.—MARBLE—DETAILED SUMMARY, BY STATES AND TERRITORIES: 1902.

	United States.	California.	Georgia.	Massachusetts.	New York.	Pennsylvania.	Tennessee.	Vermont.	Washington.	All other states and territories.[1]
Number of quarries	83	5	5	8	14	3	11	22	5	10
Number of operators	75	5	5	8	13	3	10	16	5	10
Character of ownership:										
Individual	15	1			3		2	5		4
Firm	14	2		5	2	1		2		2
Incorporated company	45	2	5	3	7	2	8	9	5	4
Other form	1				1					
Salaried officials, clerks, etc.:										
Total number	352	13	24	13	34	8	38	195	12	15
Total salaries	$341,021	$9,297	$23,050	$12,468	$40,634	$7,465	$37,430	$184,877	$10,400	$15,400
General officers—										
Number	51	1	4	2	5	2	9	20	6	2
Salaries	$99,260	$1,800	$8,700	$2,400	$11,800	$3,360	$14,200	$47,050	$4,550	$5,400
Superintendents, managers, foremen, surveyors, etc.—										
Number	197	10	14	10	19	5	25	102	4	8
Salaries	$180,783	$7,122	$11,030	$9,318	$22,382	$3,505	$20,790	$95,186	$4,350	$7,100
Clerks—										
Number	104	2	6	1	10	1	4	73	2	5
Salaries	$60,978	$375	$3,320	$750	$6,452	$600	$2,440	$42,641	$1,500	$2,900
Wage-earners:										
Total average number	4,070	50	310	130	469	169	607	2,074	63	198
Total wages	$2,212,640	$39,951	$105,709	$72,730	$332,086	$95,623	$218,764	$1,206,208	$46,099	$95,470
Engineers, firemen, and other mechanics—										
Average number	517	7	70	26	71	15	42	256	14	16
Wages	$295,524	$6,800	$30,010	$18,076	$52,556	$8,035	$18,066	$142,913	$11,228	$7,840
Quarrymen and stonecutters—										
Average number	2,513	32	163	71	307	73	412	1,244	39	172
Wages	$1,418,332	$26,782	$53,554	$38,242	$242,981	$54,322	$139,888	$748,217	$30,271	$84,075
Boys under 16 years—										
Average number	22	2	6			3	3	6	1	1
Wages	$3,756	$921	$840			$500	$360	$900	$100	$135
All other wage-earners—										
Average number	1,018	9	71	33	91	78	150	568	9	9
Wages	$495,028	$5,448	$21,305	$16,412	$36,549	$32,766	$60,450	$314,178	$4,500	$3,420
Average number of wage-earners at specified daily rates of pay:										
Engineers—										
$0.50 to $0.74	1		1							
$1.00 to $1.24	8		1				6	1		
$1.25 to $1.49	25		18			1	4			2
$1.50 to $1.74	12		1		3	3	2			3
$1.75 to $1.99	7			1	1			5		
$2.00 to $2.24	30		6	3	9			12		
$2.25 to $2.49	6			1	3	1			1	
$2.50 to $2.74	15			2				12		1
$2.75 to $2.99	1		1							
$3.00 to $3.24	6	3	1						2	
$3.75 to $3.99	1				1					
$4.00 to $4.24	1				1					
Firemen—										
$0.75 to $0.99	4		3				1			
$1.00 to $1.24	20		15				5			
$1.25 to $1.49	4									4
$1.50 to $1.74	13				3	3	2	4		1
$1.75 to $1.99	19							19		
$2.00 to $2.24	11				5			6		
$2.25 to $2.49	5			1	1				3	
$2.75 to $2.99	1								1	
$3.00 to $3.24	3								3	
Machinists, blacksmiths, carpenters, and other mechanics—										
$0.75 to $0.99	1		1							
$1.00 to $1.24	2		2							
$1.25 to $1.49	88		9			1		78		
$1.50 to $1.74	50		3	1	6	2	19	16		3
$1.75 to $1.99	22				5	1	2	14		
$2.00 to $2.24	34			7	6	1	1	18		1
$2.25 to $2.49	78	1	5	1	5	1		62	3	
$2.50 to $2.74	23		2	9	5			7		
$2.75 to $2.99	2				1			1		
$3.00 to $3.24	7	1	1		2	1		1		1
$3.25 to $3.49	4				4					
$3.50 to $3.74	10				9				1	
$3.75 to $3.99	1				1					
$4.00 to $4.24	2	2								
Quarrymen and stonecutters—										
$0.50 to $0.74	1									1
$0.75 to $0.99	12	1	9				1	1		
$1.00 to $1.24	468		115		2		344	5		2
$1.25 to $1.49	585		22	5	58	14	53	325		108
$1.50 to $1.74	438		17	49	59	20		260		33
$1.75 to $1.99	146	2			30			114		
$2.00 to $2.24	150			8	26		2	95	18	1
$2.25 to $2.49	35			3	10			6	5	11
$2.50 to $2.74	199	6			8		12	168	5	
$2.75 to $2.99	141							141		
$3.00 to $3.24	112	20		1	2			87	2	
$3.25 to $3.49	78	2		1		31		42	2	
$3.50 to $3.74	47	1		4	18	8			1	15
$3.75 to $3.99	2								2	
$4.00 to $4.24	4								3	1
$4.25 and over	95				94				1	
Boys under 16 years—										
Less than $0.50	6		4				1			1
$0.50 to $0.74	14		2			3	2	6	1	
$1.50 to $1.74	2	2								

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[1] Includes operators distributed as follows: Alabama, 1; Arkansas, 1; Connecticut, 1; Maryland, 2; Montana, 1; New Mexico, 2; Utah, 2.

TABLE 39.—MARBLE—DETAILED SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

	United States.	California.	Georgia.	Massachusetts.	New York.	Pennsylvania.	Tennessee.	Vermont.	Washington.	All other states and territories.
Average number of wage-earners at specified daily rates of pay—Continued.										
All other wage-earners—										
$0.50 to $0.74	1								1	
$0.75 to $0.99	44		37					7		
$1.00 to $1.24	60	1	31		2			18	2	6
$1.25 to $1.49	261	2	[illegible]		70	58		128		
$1.50 to $1.74	343	1		31	15	20	150	121	3	2
$1.75 to $1.99	92				3			89		
$2.00 to $2.24	68	3						65		
$2.25 to $2.49	58							55	2	1
$2.50 to $2.74	57	2		2	1			52		
$2.75 to $2.99	14							14		
$3.00 to $3.24	2							1	1	
$4.00 to $4.24	8							8		
$4.25 and over	10							10		
Average number of wage-earners employed during each month:										
Men 16 years and over—										
January	3,546	29	466	107	211	112	601	1,775	80	165
February	3,593	38	419	110	224	127	[illegible]	1,832	77	165
March	3,855	42	363	112	239	132	601	2,097	78	191
April	4,064	43	331	119	361	149	604	2,210	49	198
May	4,294	36	302	130	521	160	604	2,283	58	200
June	4,165	19	255	136	535	181	604	2,178	52	205
July	4,166	67	252	141	554	180	606	2,114	52	200
August	4,288	61	239	141	677	188	606	2,095	56	225
September	4,409	65	253	143	630	230	606	2,194	60	228
October	4,255	67	245	145	633	198	607	2,097	49	214
November	4,100	56	241	138	593	185	604	2,001	68	214
December	3,921	63	262	138	550	150	604	1,940	65	159
Boys under 16 years—										
January	28	2	9			3	3	6	3	2
February	25	2	7			3	3	5	3	2
March	25	2	7			3	3	5	3	2
April	26	2	8			3	3	6	3	1
May	22	2	8			3	3	6		
June	19	2	5			3	3	6		
July	20	2	5			3	3	7		
August	20	2	5			3	3	6		1
September	21	2	5			3	3	7		1
October	20	2	5			3	3	6		1
November	19	2	1			3	3	6		1
December	19	2	4			3	3	6		1
Miscellaneous expenses:										
Total	$382,877	$6,487	$68,557	$7,837	$31,283	$4,271	$11,268	$226,103	$9,350	$17,718
Royalties and rent of quarrying plant	$65,385	$900	$15,412	$460	$6,025	$300	$6,100	$27,663		$8,525
Rent of offices, taxes, insurance, interest, and other sundries	$317,492	$5,587	$53,145	$7,377	$25,258	$3,971	$5,168	$198,440	$9,350	$9,193
Cost of supplies and materials	$825,822	$10,317	$77,205	$18,324	$100,705	$29,430	$18,725	$523,075	$22,349	$26,692
Value of product:										
Total	$5,044,182	$92,298	$660,517	$165,489	$577,298	$160,423	$518,256	$2,626,164	$61,176	$190,561
Rough—										
All purposes	$2,276,629	$33,198	$597,017	$51,696	$167,005	$22,446	$257,837	$1,056,132	$9,103	$92,196
Dressed—										
Building	$1,038,102		$50,000	$81,394	$267,013	$110,977		$433,285	$31,873	$63,580
Monumental	$956,870	$4,000	$7,500		$143,080	$24,000	$9,000	$758,390		$10,900
Ornamental	$7,300	$100		$6,000	$200					$1,000
Interior decoration	$679,913	$55,000	$6,000	$15,056			$240,419	$321,689	$19,200	$22,549
Other uses	$85,368			$11,344		$3,000	$11,000	$58,688	$1,000	$836
Power owned:										
Total horsepower	14,286	150	1,302	1,027	1,061	900	1,245	7,586	170	785
Engines—										
Steam—										
Number	191	3	56	17	14	12	21	50	6	12
Horsepower	10,748	150	1,302	840	885	900	1,245	4,411	170	785
Water wheels—										
Number	15			2	2			11		
Horsepower	3,413			187	176			3,050		
Other power—										
Number	2							2		
Horsepower	125							125		
Electric motors owned—										
Number	32	3		1	5	14		9		
Horsepower	2,220	80		40	140	300		1,660		

TABLE 40.—SANDSTONES AND QUARTZITES—DETAILED

		United States.	Alabama.	Arizona.	Arkansas.	California.	Colorado.	Connecticut.
1	Number of quarries	1,304	7	4	18	75	51	7
2	Number of operators	1,211	7	4	17	[illegible]	47	7
	Character of ownership:							
3	Individual	759	5	2	12	4	26	2
4	Firm	324	1	1	2	3	15	2
5	Incorporated company	119	1	1	3	4	5	3
6	Other form	9					1	
	Salaried officials, clerks, etc.:							
7	Total number	847	6	9	11	8	33	15
8	Total salaries	$713,379	$2,[illegible]	$16,775	$5,806	$11,840	$28,704	$13,[illegible]
	General officers—							
9	Number	101		3	2	1	3	5
10	Salaries	$254,[illegible]		$10,250	$870	$2,000	$4,[illegible]	$4,000
	Superintendents, managers, foremen, surveyors, etc.—							
11	Number	531	4	3	7	7	23	9
12	Salaries	$408,486	$2,250	$4,575	$4,071	$9,840	$19,75[illegible]	$8,951
	Clerks—							
13	Number	215	1	3	2		7	1
14	Salaries	$150,572	$500	$[illegible]	$865		$4,718	$600
	Wage-earners:							
15	Total average number	10,418	58	32	111	363	313	112
16	Total wages	$6,173,[illegible]	$30,[illegible]	$24,[illegible]	$52,170	$[illegible]	$237,[illegible]	$73,[illegible]
	Engineers, firemen, and other mechanics—							
17	Average number	1,278	3	3	9	24	14	22
18	Wages	$779,139	$1,778	$2,[illegible]	$4,760	$[illegible]	$11,14[illegible]	$12,[illegible]
	Quarrymen and stonecutters—							
19	Average number	7,117	[illegible]	19	96	[illegible]	304	[illegible]
20	Wages	$4,126,075	$26,[illegible]	$36,372	$44,710	$211,[illegible]	$209,957	$57,[illegible]
	Boys under 16 years—							
21	Average number	76						
22	Wages	$27,142						
	All other wage-earners—							
23	Average number	2,107	5	10	6	32	25	10
24	Wages	$[illegible]	$2,[illegible]	$9,000	$2,700	$55,412	$16,803	$5,200
	Average number of wage-earners at specified daily rates of pay:							
	Engineers—							
25	$0.50 to $0.74	3						
26	$0.75 to $0.99	5						
27	$1.00 to $1.24	12		1				
28	$1.25 to $1.49	12			1			
29	$1.50 to $1.74	50			2			1
30	$1.75 to $1.99	31						1
31	$2.00 to $2.24	250	1		1			
32	$2.25 to $2.49	26						5
33	$2.50 to $2.74	38			1	2	1	
34	$2.75 to $2.99	22						
35	$3.00 to $3.24	51				12	1	
36	$3.25 to $3.49	7		1				
37	$3.50 to $3.74	3				1		
38	$4.00 to $4.24	2						
	Firemen—							
39	$0.75 to $0.99	1						
40	$1.00 to $1.24	2						
41	$1.25 to $1.49	38						
42	$1.50 to $1.74	18			1			1
43	$1.75 to $1.99	178						2
44	$2.00 to $2.24	24						1
45	$2.25 to $2.49	1						
46	$2.50 to $2.74	3						
47	$2.75 to $2.99	1						
48	$3.00 to $3.24	1						
	Machinists, blacksmiths, carpenters, and other mechanics—							
49	$0.50 to $0.74	1						
50	$0.75 to $0.99	5	1					
51	$1.00 to $1.24	14						
52	$1.25 to $1.49	29			1			
53	$1.50 to $1.74	54						2
54	$1.75 to $1.99	117						3
55	$2.00 to $2.24	89						1
56	$2.25 to $2.49	36					1	
57	$2.50 to $2.74	51	1				1	1
58	$2.75 to $2.99	23					2	
59	$3.00 to $3.24	14					3	
60	$3.25 to $3.49	13						
61	$3.50 to $3.74	1						
62	$3.75 to $3.99	1		1		1		
63	$4.00 to $4.24	2				2		
	Quarrymen and stonecutters—							
64	$0.50 to $0.74	9						
65	$0.75 to $0.99	10						
66	$1.00 to $1.24	125			12		8	5
67	$1.25 to $1.49	87	23		11			2
68	$1.50 to $1.74	1,7[illegible]	10		26		99	38
69	$1.75 to $1.99	1,[illegible]		1	13	25	9[illegible]	64
70	$2.00 to $2.24	1,[illegible]				140	[illegible]	2
71	$2.25 to $2.49	[illegible]	12			3	54	1
72	$2.50 to $2.74	2[illegible]			5	18	9[illegible]	
73	$2.75 to $2.99	211					32	
74	$3.00 to $3.24	57[illegible]			5	112	9	
75	$3.25 to $3.49	30						1
76	$3.50 to $3.74	104	4	8				
77	$3.75 to $3.99	13						
78	$4.00 to $4.24	81					2	
79	$4.25 and over	30					4	
	Boys under 16 years—							
80	Less than $0.50	4						
81	$0.50 to $0.74	2						
82	$0.75 to $0.99	25						
83	$1.00 to $1.24	78						
84	$1.25 to $1.49	2						
85	$1.75 to $1.99	2						

[1] Includes 1 operator in Hawaii.

SUMMARY, BY STATES AND TERRITORIES: 1902.

Idaho.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Maryland.	Massachusetts.	Michigan.	Minnesota.	
11	18	9	32	19	9	5	19	9	13	1
10	18	9	32	18	9	5	15	8	12	2
7	12	5	25	13	2	5	8		6	3
2	5	3	6	2	2		4	1	3	4
1		1	1	3	4		1	7	3	5
	1				1		2			6
1	2	6	1	3	16	2	35	25	15	7
$1,232	$1,200	$4,650	$900	$3,400	$10,270	$1,148	$25,536	$28,470	$18,654	8
		1		2	1			4	1	9
		$1,200		$2,400	$720			$7,100	$6,700	10
1	2	3	1	1	14	2	24	15	12	11
$1,232	$1,200	$2,100	$900	$1,000	$8,950	$1,148	$19,274	$15,020	$11,300	12
		2			1		11	6	2	13
		$1,350			$600		$6,262	$6,350	$654	14
7	22	41	12	137	166	12	342	151	305	15
$4,655	$10,295	$19,567	$5,586	$67,459	$63,589	$5,394	$222,977	$80,108	$215,068	16
	3	6		5	19	2	31	21	28	17
	$1,050	$3,095		$2,725	$8,394	$864	$21,788	$11,218	$18,654	18
7	19	24	12	87	96	9	297	124	276	19
$4,655	$9,245	$10,949	$5,586	$42,734	$38,678	$4,368	$194,189	$66,940	$196,014	20
		1		2	1	1		3		21
		$225		$575	$50	$162		$540		22
		10		43	50		14	3	1	23
		$5,298		$21,425	$16,467		$7,000	$1,410	$400	24
										25
	1									26
		1							1	27
	2				4					28
				2	1	1	1			29
					2					30
		1					1	2	2	31
				1			1	1	1	32
							1	1	2	33
							1			34
							1	2		35
							2			36
										37
										38
										39
										40
										41
					2			1		42
								1		43
								3	1	44
										45
										46
										47
										48
										49
					1					50
	1	1			1				1	51
						1				52
				1	2					53
					1					54
		1		1	2		1	6	4	55
							2	2	11	56
							3	1	1	57
							8			58
							1		1	59
										60
									1	61
									1	62
										63
			1	2						64
	1		1	1					1	65
		11	1	1	4					66
	7	3	1	9	81				10	67
	2	2	2	32	6	9	10	9	1	68
1	2	3	3	35			4	68	96	69
2	6	3	2	3			250	42	65	70
	1							5	7	71
4				4	1		1		1	72
										73
									46	74
									11	75
		2			1		2		18	76
			1						12	77
							21		8	78
										79
				1	1					80
						1		2		81
		1		1				1		82
										83
										84
										85

TABLE 40.—SANDSTONES AND QUARTZITES—DETAILED

		United States.	Alabama.	Arizona.	Arkansas.	California.	Colorado.	Connecticut.
	Average number of wage-earners at specified daily rates of pay—Continued.							
	All other wage-earners—							
86	$0.50 to $0.74	1						
87	$0.75 to $0.99	5	1					
88	$1.00 to $1.24	125						
89	$1.25 to $1.49	561						10
90	$1.50 to $1.74	706	2		6			
91	$1.75 to $1.99	267						
92	$2.00 to $2.24	173	2	10		50	14	
93	$2.25 to $2.49	70					11	
94	$2.50 to $2.74	31				1		
95	$2.75 to $2.99	1						
96	$3.00 to $3.24	3						
97	$3.50 to $3.74	4						
	Average number of wage-earners employed during each month.							
	Men 16 years and over—							
98	January	5,693	67	31	61	353	199	46
99	February	5,766	67	31	47	346	268	52
100	March	7,719	67	31	57	355	324	93
101	April	10,558	44	31	68	364	360	162
102	May	12,673	63	31	93	378	381	219
103	June	13,301	71	31	96	390	362	223
104	July	13,257	71	31	91	384	378	208
105	August	13,041	50	31	108	376	369	207
106	September	12,609	55	31	134	373	405	187
107	October	11,897	55	31	219	362	392	139
108	November	10,428	43	37	193	325	375	115
109	December	7,712	43	27	165	345	313	58
	Boys under 16 years—							
110	January	31						
111	February	28						
112	March	46						
113	April	67						
114	May	105						
115	June	105						
116	July	111						
117	August	111						
118	September	96						
119	October	83						
120	November	78						
121	December	48						
	Contract work:							
122	Amount paid	$500						
123	Number of employees	1						
	Miscellaneous expenses:							
124	Total	$878,780	$1,535	$9,005	$1,530	$14,758	$12,069	$6,881
125	Royalties and rent of quarrying plant	$196,144	$1,480		$350	$6,130	$4,631	$95
126	Rent of offices, taxes, insurance, interest, and other sundries.	$682,636	$55	$9,005	$1,180	$8,628	$7,438	$6,786
127	Cost of supplies and materials	$1,298,190	$5,230	$50,229	$7,915	$80,967	$36,196	$14,668
	Value of product.							
128	Total	$10,601,171	$42,706	$107,910	$85,917	$469,016	$366,161	$128,579
	Building—							
129	Rough	$3,119,236		$9,570	$8,374	$80,038	$93,116	$123,634
130	Dressed	$2,888,248	$14,252	$75,000	$1,420	$123,240	$15,267	$4,945
	Crushed—							
131	Roadmaking, macadam, etc	$442,113				$44,438		
132	Railroad ballast, etc	$347,969			$38,475	$4,000	$65,000	
133	Concrete	$326,467	$200		$6,271	$146,000	$6,008	
134	Ganister	$112,600						
135	Riprap	$269,269	$8,727	$4,800	$415	$71,090	$2,347	
136	Rubble	$645,619	$16,675	$18,300	$3,115	$210	$37,998	
137	Paving	$527,617			$9,810		$718	
138	Flagging	$1,142,699			$2,979		$101,486	
139	Curbing	$672,654			$14,878		$42,607	
140	Other uses	$106,760	$2,852	$240	$180		$1,014	
	Power:							
141	Total horsepower	25,652	20	80	320	439	195	564
	Owned—							
	Engines—							
	Steam—							
142	Number	789	1	3	9	18	9	11
143	Horsepower	24,631	20	80	317	129	195	564
	Gas or gasoline—							
144	Number	7			1			
145	Horsepower	72			3			
	Water wheels—							
146	Number	6						
147	Horsepower	885						
	Other power—							
148	Number	8				1		
149	Horsepower	58				10		
	Rented—							
150	Electric, horsepower	7						
151	Other power, horsepower	4						
	Electric motors owned—							
152	Number	6						
153	Horsepower	60						

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Idaho.	Illinois.	Indiana	Iowa.	Kansas.	Kentucky.	Maryland.	Massachusetts	Michigan	Minnesota	
										86
					1		1			87
		2			25					88
		1		4	24			1		89
		1		8			6	2	1	90
		6		20			7			91
										92
										93
				1						94
										95
										96
										97
1	5	31	9	92	160	3	176	19	132	98
5	5	31	10	92	169		227	42	131	99
7	17	31	9	137	169	14	264	50	202	100
5	27	47	12	146	169	18	234	174	216	101
5	32	47	13	140	169	15	371	251	357	102
17	37	48	8	152	169	13	388	244	360	103
7	35	47	11	146	202	18	426	240	357	104
5	29	47	22	158	202	14	508	233	361	105
4	26	47	17	160	202	13	469	150	358	106
4	23	35	16	151	126	12	447	132	127	107
10	19	35	11	134	125	12	368	116	120	108
11	8	34	13	120	118		296	95	336	109
				2		1		3		110
				2		1		3		111
				2		1		3		112
				2		1		3		113
		1		2		1		3		114
		1		2		1		3		115
		2		2	2	1		3		116
		2		2	2	1		3		117
		2		2	2	1		3		118
		2		2	2	1		3		119
		1		2	2	1		3		120
		1		2	2	1		3		121
										122
										123
$615	$1,916	$1,706	$527	$5,760	$928	$51	$35,140	$20,642	$45,740	124
$6	$1,133	$928	$272	$2,607	$27		$19,882	$5,235	$7,471	125
$609	$783	$778	$255	$3,153	$901	$51	$15,258	$15,407	$38,269	126
$552	$1,955	$1,040	$527	$15,914	$10,105	$1,152	$50,186	$13,723	$13,159	127
$13,777	$82,200	$37,868	$15,081	$105,540	$128,470	$15,406	$487,366	$188,073	$847,472	128
$7,823	$21,185	$24,866	$9,044	$10,157	$47,775	$7,210	$93,197	$136,290	$30,796	129
$434	$4,100	$5,564	$775	$2,060	$5,000		$96,393	$23,600	$70,935	130
	$25	$1,000	$750		$5,100	$10	$206,278		$5,400	131
				$12,050	$50,000	$1,500				132
			$35			$1,155	$40,256		$15,699	133
										134
	$1,000	$450				$545		$800	$4,061	135
$5,520	$2,928	$1,069	$3,157	$6,162		$1,085	$1,000	$27,594	$20,351	136
	$2,100	$240		$275	$1,075				$140,728	137
	$160	$120	$75	$21,124	$7,420				$225	138
		$1,588		$23,561	$4,900		$45		$13,670	139
	$105		$1,225	$100	$6,700	$650			$6,620	140
	46	128	12	137	1,350	25	883	530	1,653	141
	4	4	1	7	14	1	22	18	11	142
	46	128	12	137	1,350	25	883	530	828	143
										144
										145
									3	146
									825	147
		1								148
		8								149
										150
										151
									1	152
									15	153

TABLE 40.—SANDSTONES AND QUARTZITES—DETAILED

		Missouri.	Montana.	Nevada.	New Jersey.	New Mexico.	New York.	Ohio.
1	Number of quarries	10	8	3	22	7	377	115
2	Number of operators	10	8	3	22	7	364	91
	Character of ownership:							
3	Individual	5	6	2	12	6	228	38
4	Firm	3	1		4	1	128	28
5	Incorporated company	2	1		6		8	25
6	Other form			1				
	Salaried officials, clerks, etc.:							
7	Total number	7	2		28		86	200
8	Total salaries	$3,375	$3,900		$17,847		$67,463	$218,590
	General officers—							
9	Number	3			2		6	40
10	Salaries	$715			$185		$12,000	$75,695
	Superintendents, managers, foremen, surveyors, etc.—							
11	Number	4	1		16		64	85
12	Salaries	$2,660	$2,100		$12,392		$46,488	$72,653
	Clerks—							
13	Number		1		10		16	75
14	Salaries		$1,800		$5,270		$8,975	$70,242
	Wage-earners:							
15	Total average number	56	57	2	418	8	1,284	2,363
16	Total wages	$31,989	$52,117	$1,583	$232,480	$6,515	$785,694	$1,171,674
	Engineers, firemen, and other mechanics—							
17	Average number	10	7		28		69	618
18	Wages	$5,276	$6,400		$15,681		$41,987	$354,295
	Quarrymen and stonecutters—							
19	Average number	34	29	2	358	8	1,065	1,019
20	Wages	$21,475	$29,117	$1,583	$202,345	$6,515	$676,412	$506,539
	Boys under 16 years—							
21	Average number	1			2		8	18
22	Wages	$124			$400		$2,120	$3,840
	All other wage-earners—							
23	Average number	11	21		30		142	708
24	Wages	$5,114	$16,600		$14,054		$65,175	$307,000
	Average number of wage-earners at specified daily rates of pay:							
	Engineers—							
25	$0.50 to $0.74				1			
26	$0.75 to $0.99							1
27	$1.00 to $1.24	1			1		5	1
28	$1.25 to $1.49	1						3
29	$1.50 to $1.74				6		2	10
30	$1.75 to $1.99	1			1		3	11
31	$2.00 to $2.24	1	1		2		11	199
32	$2.25 to $2.49				2		1	14
33	$2.50 to $2.74				2		5	7
34	$2.75 to $2.99		1					
35	$3.00 to $3.24		1					
36	$3.25 to $3.49		1		2			
37	$3.50 to $3.74							
38	$4.00 to $4.24							
	Firemen—							
39	$0.75 to $0.99							
40	$1.00 to $1.24						1	
41	$1.25 to $1.49						1	6
42	$1.50 to $1.74	1					2	1
43	$1.75 to $1.99	1			1			152
44	$2.00 to $2.24	1			2			4
45	$2.25 to $2.49							1
46	$2.50 to $2.74							
47	$2.75 to $2.99							
48	$4.00 to $4.24							
	Machinists, blacksmiths, carpenters, and other mechanics—							
49	$0.50 to $0.74							1
50	$0.75 to $0.99				1			
51	$1.00 to $1.24	1					2	2
52	$1.25 to $1.49	1			2		1	4
53	$1.50 to $1.74				3		1	19
54	$1.75 to $1.99						5	127
55	$2.00 to $2.24						10	40
56	$2.25 to $2.49				1		4	8
57	$2.50 to $2.74				1		9	2
58	$2.75 to $2.99						3	1
59	$3.00 to $3.24	1						
60	$3.25 to $3.49		2					1
61	$3.50 to $3.74		1					
62	$3.75 to $3.99							
63	$4.00 to $4.24							
	Quarrymen and stonecutters—							
64	$0.50 to $0.74						1	
65	$0.75 to $0.99					1	3	1
66	$1.00 to $1.24		1				10	21
67	$1.25 to $1.49	2			72		58	58
68	$1.50 to $1.74	6			131		138	554
69	$1.75 to $1.99	10	3		55	1	201	117
70	$2.00 to $2.24	10			22		315	196
71	$2.25 to $2.49		1		14		91	41
72	$2.50 to $2.74		2	2	9	2	25	9
73	$2.75 to $2.99		7		3		28	5
74	$3.00 to $3.24	3	1		32	1	88	5
75	$3.25 to $3.49		2		1		25	3
76	$3.50 to $3.74				7		11	5
77	$3.75 to $3.99					3		
78	$4.00 to $4.24	3			8		7	4
79	$4.25 and over		12		4			
	Boys under 16 years—							
80	Less than $0.50	1						1
81	$0.50 to $0.74						3	8
82	$0.75 to $0.99				2		2	3
83	$1.00 to $1.24						1	6
84	$1.25 to $1.49						2	
85	$1.75 to $1.99							

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[1] Includes operators distributed as follows: Georgia, 1; Nebraska, 1; North Carolina, 2; Oklahoma, 1; Oregon, 1; Virginia, 2.

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Pennsylvania.	South Dakota.	Tennessee.	Texas.	Utah.	Washington.	West Virginia.	Wisconsin.	Wyoming.	All other states and territories.[1]	
283	12	3	13	10	3	110	62	12	8	1
258	12	3	13	6	3	100	62	12	8	2
161	9		8	3	2	82	19	9	5	3
70	1	2	4		1	18	8	2	1	4
20	1		1	3			5	1	3	5
1	1	1								6
272	4	3	11	6	4	38	13	3	3	7
$177,796	$2,833	$1,140	$8,669	$6,720	$4,100	$18,965	$9,129	$2,008	$1,735	8
23							1			9
$25,256							$1,200			10
170	8	2	9	3	3	33	9	1	3	11
$122,455	$2,353	$780	$7,489	$4,500	$5,620	$15,865	$6,654	$800	$1,755	12
59	1	1	2	3	1	5	2	2		13
$30,045	$480	$360	$1,290	$2,220	$500	$3,100	$1,275	$1,238		14
2,864	94	10	191	65	32	453	199	71	34	15
$1,779,963	$62,509	$4,066	$100,392	$50,225	$23,237	$272,123	$109,066	$58,697	$14,092	16
253	6	2	13	1	4	10	17	4	3	17
$178,848	$6,800	$780	$9,165	$3,250	$3,095	$12,071	$9,431	$4,353	$1,267	18
1,966	81	8	158	35	27	255	179	55	31	19
$1,258,887	$59,928	$3,306	$81,732	$30,150	$19,642	$182,789	$98,427	$45,578	$12,815	20
25	1			1		11	1			21
$8,876	$150			$150		$2,919	$108			22
630	4		22	25	1	168	2	15		23
$296,412	$2,601		$9,562	$16,675	$500	$74,811	$1,100	$8,966		24
							1		1	25
1										26
							1			27
1				1						28
18						1			1	29
6						2	2			30
9			1			1	3		1	31
6							1			32
34			4		2	1	1			33
19							1			34
6			2	1				1		35
				1						36
	1						1			37
								1		38
			1							39
1										40
4			1				1			41
2							1			42
20						1				43
6										44
										45
1						2				46
	1									47
										48
										49
3										50
							1			51
10										52
1							1			53
6						2				54
16		1	1			5				55
9						1				56
21	1	1			1	2	2			57
11	1		1		1					58
34						1		2		59
5	4			1						60
1										61
										62
										63
1						1	2		1	64
1			2	1				1	6	65
30		7		1		2	4	2	6	66
192			2		3	6	8			67
381	1		37			32	34	1	14	68
260	8		38	2		60	74	1	2	69
434	48		3	1		50	84	3	1	70
56				7	12	5	2	6		71
98	6	1			5	10			1	72
107	6			10		12		1		73
154			2	4	7	51	21	72		74
31	2		5			8		1		75
191				1		9	5	7		76
			7							77
13				8		7				78
	10									79
										80
8	1			1		1	1			81
10						5				82
6						6				83
										84
1										85

TABLE 40.—SANDSTONES AND QUARTZITES—DETAILED

		Missouri.	Montana.	Nevada.	New Jersey.	New Mexico.	New York.	Ohio.
	Average number of wage-earners at specified daily rates of pay—Continued.							
	All other wage-earners—							
86	$0.50 to $0.74							
87	$0.75 to $0.99						1	1
88	$1.00 to $1.24				2			65
89	$1.25 to $1.49	9			12		14	225
90	$1.50 to $1.74				9		111	802
91	$1.75 to $1.99	1			3		9	55
92	$2.00 to $2.24				2		3	58
93	$2.25 to $2.49		11				8	23
94	$2.50 to $2.74		10		2			
95	$2.75 to $2.99						1	
96	$3.00 to $3.24	1						1
97	$3.50 to $3.74							
	Average number of wage-earners employed during each month:							
	Men 16 years and over—							
98	January	36	51		294	5	376	1,596
99	February	39	54		345	6	410	1,269
100	March	40	50		384	6	551	1,766
101	April	52	61		518	6	1,036	2,375
102	May	76	63		553	8	1,757	2,818
103	June	84	66	4	514	13	2,043	2,851
104	July	75	63	4	510	10	1,995	2,845
105	August	63	62	4	484	8	1,861	2,802
106	September	62	58	3	422	12	1,778	2,721
107	October	56	60	3	404	10	1,613	2,680
108	November	50	48	3	345	6	1,246	2,512
109	December	36	39	3	210	6	637	1,985
	Boys under 16 years—							
110	January				2		2	10
111	February				2		2	2
112	March	2			2		2	10
113	April	1			2		5	15
114	May	2			2		13	23
115	June	1			2		17	15
116	July	2			2		14	26
117	August	1			2		14	26
118	September	2			2		8	25
119	October	1			2		8	26
120	November				2		9	26
121	December				2		2	12
	Contract work:							
122	Amount paid							
123	Number of employees							
	Miscellaneous expenses:							
124	Total	$621	$3,882	$351	$18,352	$536	$104,493	$437,827
125	Royalties and rent of quarrying plant	$92	$3,011	$351	$13,647		$31,309	$16,595
126	Rent of offices, taxes, insurance, interest, and other sundries.	$529	$838		$4,705	$536	$73,184	$421,232
127	Cost of supplies and materials	$7,664	$5,810	$250	$36,100	$370	$108,159	$526,121
	Value of product.							
128	Total	$56,990	$85,152	$6,115	$406,726	$12,250	$1,408,699	$2,078,751
	Building—							
129	Rough	$32,880	$1,822	$2,383	$232,051	$6,500	$279,009	$1,167,898
130	Dressed	$15,323	$61,158		$81,145	$2,125	$271,430	$211,962
	Crushed—							
131	Roadmaking, macadam, etc				$50		$50,117	$1,554
132	Railroad ballast, etc	$900					$3,795	$75
133	Concrete	$450	$750		$30,880		$5,310	$6,675
134	Ganister							$1,726
135	Riprap	$345	$5,795				$5,152	$21,853
136	Rubble	$3,001	$4,162	$3,657	$59,777	$50	$18,583	$41,171
137	Paving					$600	$251,858	$750
138	Flagging	$881	$840		$2,200	$775	$220,158	$664,659
139	Curbing	$1,710	$2,455	$75		$950	$272,821	$43,077
140	Other uses	$1,500	$7,340		$623	$1,250	$6,856	$14,135
	Power:							
141	Total horsepower	320	89		614		2,062	8,708
	Owned—							
	Engines—							
	Steam—							
142	Number	15	3		29		76	212
143	Horsepower	320	85		614		2,017	8,631
	Gas or gasoline—							
144	Number						1	3
145	Horsepower						15	41
	Water wheels—							
146	Number						1	2
147	Horsepower						30	30
	Other power—							
148	Number							
149	Horsepower							
	Rented—							
150	Electric, horsepower							
151	Other power, horsepower		4					
	Electric motors owned—							
152	Number						1	2
153	Horsepower						1	22

[1] Includes operators distributed as follows: Georgia, 1; Nebraska, 1; North Carolina, 2; Oklahoma, 1; Oregon, 1; Virginia, 2.

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Pennsylvania.	South Dakota	Tennessee.	Texas	Utah.	Washington.	West Virginia.	Wisconsin	Wyoming.	All other states and territories.[1]	
				1						86
										87
23	1					6		1		88
196						75				89
219			22		1	76				90
150						6	2			91
37	2				2		13			92
				21				1		93
14				3						94
										95
1										96
	1					3				97
1,606	70	5	81	40	12	127	29		29	98
1,600	78	5	138	49		175	42	3	29	99
2,279	86	5	246	55	24	287	112	24	34	100
2,897	112	5	256	54	37	474	240	100	38	101
3,400	110	6	252	81	43	535	276	107	38	102
3,565	115	6	246	83	45	585	324	112	36	103
3,574	101	18	229	80	42	611	279	125	44	104
3,578	101	18	168	88	39	615	290	117	48	105
3,198	102	13	161	80	37	606	273	110	37	106
3,223	98	13	171	70	35	593	218	68	28	107
2,726	66	13	179	50	47	491	195	62	29	108
2,123	57	13	185	38	23	205	108	60	18	109
9						5				110
10						6				111
15						9				112
26						12				113
42	2					14				114
45	2					14	2			115
89	2			2		14				116
38	2			2		14	2			117
29	2			2		14	2			118
19	2			2		11	2			119
17				2		11	2			120
11				2		8	2			121
										122
										123
$108,608	$4,689	$329	$7,644	$4,460	$350	$17,533	$5,632	$2,291	$4,019	124
$51,792	$2,259		$5,415	$840		$14,756	$817	$1,310	$3,850	125
$56,816	$2,410	$329	$2,229	$3,620	$350	$2,777	$2,815	$981	$169	126
$208,883	$9,703	$660	$21,261	$5,070	$4,316	$28,500	$17,169	$4,337	$670	127
$2,800,108	$110,789	$7,670	$165,565	$105,011	$30,725	$423,582	$207,086	$90,691	$34,052	128
$491,235	$19,970	$6,950	$4,832	$63,529	$2,500	$104,601	$51,392	$14,008	$29,577	129
$1,125,724	$22,192	$600	$28,000	$255	$15,225	$193,157	$85,353	$25,448	$4,324	130
$59,742			$16,300			$3,985	$83	$25,100	$1,046	131
$129,591	$168					$8,685	$920			132
$18,972			$25,907			$12,361	$51	$9,162	$25	133
$92,171							$18,884			134
$62,927	$3,652		$59,919		$8,000	$3,323	$5,493	$332		135
$202,295	$24,417		$7,000		$5,000	$79,030	$29,700	$10,026	$90	136
$26,985	$39,250			$35,300			$160	$5,000		137
$104,521				$2,200		$2,745		$600		138
$174,184	$500		$22,850	$4,010		$15,635	$112	$50		139
$40,461	$600	$130	$757	$7			$12,575			140
5,647	58		262	120	117	481	526	121	145	141
240	3		17	6	3	24	17	3	6	142
5,685	58		252	120	105	481	508	121	145	143
1							1			144
2							8			145
										146
										147
1			1		1		3			148
10			10		12		3			149
							7			150
										151
							2			152
							22			153

TABLE 41.—SILICA SAND—DETAILED SUMMARY, BY STATES: 1902.

	United States.	Ohio.	Pennsylvania.
Number of quarries	26	10	16
Number of operators	20	7	[1] 13
Character of ownership:			
Individual	5	2	3
Firm	5	2	3
Incorporated company	10	3	7
Salaried officials, clerks, etc.:			
Total number	35	18	17
Total salaries	$27,228	$13,988	$13,240
General officers—			
Number	9	7	2
Salaries	$10,240	$7,040	$3,200
Superintendents, managers, foremen, surveyors, etc.—			
Number	18	7	11
Salaries	$13,108	$5,508	$7,600
Clerks—			
Number	8	4	4
Salaries	$3,880	$1,440	$2,440
Wage-earners:			
Total average number	335	155	180
Total wages	$149,114	$69,675	$79,439
Engineers, firemen, and other mechanics—			
Average number	32	11	21
Wages	$18,140	$6,769	$11,371
Quarrymen—			
Average number	149	70	79
Wages	$66,074	$32,028	$34,046
All other wage-earners—			
Average number	154	74	80
Wages	$64,900	$30,878	$34,022
Average number of wage-earners at specified daily rates of pay:			
Engineers—			
$1.25 to $1.49	1		1
$1.50 to $1.74	4	1	3
$1.75 to $1.99	1		1
$2.00 to $2.24	13	5	8
$2.50 to $2.74	2	2	
Firemen—			
$1.50 to $1.74	3		3
Machinists, blacksmiths, carpenters, and other mechanics—			
$1.50 to $1.74	1		1
$1.75 to $1.99	2	1	1
$2.00 to $2.24	4	2	2
$2.50 to $2.74	1		1
Quarrymen—			
$0.75 to $0.99	2	2	
$1.25 to $1.49	73	21	52
$1.50 to $1.74	41	25	16
$1.75 to $1.99	13	12	1
$2.00 to $2.24	20	10	10
All other wage-earners—			
$1.25 to $1.49	57	31	26
$1.50 to $1.74	79	43	36
$1.75 to $1.99	2		2
$2.00 to $2.24	16		16

	United States.	Ohio.	Pennsylvania.
Average number of wage-earners employed during each month:			
Men 16 years and over—			
January	270	128	142
February	264	122	142
March	335	154	181
April	333	147	186
May	355	160	195
June	341	145	196
July	332	136	196
August	366	170	196
September	380	176	204
October	365	186	179
November	328	162	166
December	332	165	166
Contract work:			
Amount paid	$100	$100	
Number of employees	2	2	
Miscellaneous expenses:			
Total	$18,776	$7,566	$11,210
Royalties and rent of quarrying plant	$8,373	$3,139	$5,234
Rent of offices, taxes, insurance, interest, and other sundries	$10,403	$4,427	$5,976
Cost of supplies and materials	$38,386	$13,598	$24,788
Product:			
Total quantity (short tons)	445,903	132,921	312,982
Total value	$421,889	$152,274	$269,615
Glass sand—			
Quantity (short tons)	147,555	20,035	127,520
Value	$130,253	$24,886	$105,367
Engine sand—			
Quantity (short tons)	3,750	3,750	
Value	$3,000	$3,000	
Furnace sand—			
Quantity (short tons)	75,507	60,296	15,211
Value	$78,244	$59,348	$18,896
Building sand—			
Quantity (short tons)	31,500		31,500
Value	$21,000		$21,000
Other uses—			
Quantity (short tons)	187,450	48,729	138,721
Value	$185,782	$65,030	$120,752
Power owned:			
Total horsepower	2,000	805	1,195
Steam—			
Engines—			
Number	33	16	17
Horsepower	1,980	785	1,195
Other power—			
Number	1	1	
Horsepower	20	20	

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[1] Includes 2 operators in West Virginia.

TABLE 42.—SILICEOUS CRYSTALLINE ROCKS—DETAILED

		United States.	Arkansas.	California.	Colorado.	Connecticut.	Delaware.	Georgia.	Maine.	Maryland.	Massachusetts.	Minnesota.	Missouri.
1	Number of quarries	906	3	64	10	49	6	26	110	17	204	27	11
2	Number of operators	853	3	62	10	44	6	24	103	13	194	26	9
	Character of ownership:												
3	Individual	436	1	35	5	25	2	10	54	5	125	9	2
4	Firm	219	2	14		8	2	8	31	3	29	11	2
5	Incorporated company	176		13	5	9	2	6	18	5	25	4	5
6	Other form	22				2					15	2	
	Salaried officials, clerks, etc.:												
7	Total number	1,377	2	38	7	87	16	45	163	65	279	36	16
8	Total salaries	$1,227,885	$1,650	$45,054	$6,345	$75,682	$15,307	$34,536	$158,516	$67,925	$248,512	$40,719	$11,614
	General officers—												
9	Number	136		4		10	3	4	13	17	14	4	1
10	Salaries	$220,180		$10,360		$12,529	$6,000	$5,205	$20,048	$32,376	$33,295	$6,000	$800
	Superintendents, managers, foremen, surveyors, etc.—												
11	Number	923	1	27	6	60	8	32	108	33	202	27	12
12	Salaries	$799,195	$750	$29,134	$5,325	$52,062	$6,551	$24,621	$101,890	$27,897	$175,671	$31,520	$8,616
	Clerks—												
13	Number	318	1	7	1	17	5	9	42	15	63	5	3
14	Salaries	$208,510	$900	$5,560	$1,020	$11,091	$2,756	$4,710	$36,578	$7,652	$39,546	$3,199	$2,198
	Wage-earners:												
15	Total average number	18,836	10	920	46	943	335	724	2,832	817	3,395	414	179
16	Total wages	$11,072,996	$4,260	$687,658	$34,072	$545,334	$153,150	$382,559	$1,867,200	$435,372	$2,045,340	$317,622	$104,624
	Engineers, firemen, and other mechanics—												
17	Average number	1,916	1	58	5	122	30	59	297	98	366	41	23
18	Wages	$1,300,178	$600	$48,334	$4,000	$80,890	$19,177	$43,778	$207,172	$61,233	$257,398	$31,178	$17,725
	Quarrymen and stonecutters—												
19	Average number	14,474	9	708	38	666	173	538	2,254	616	2,513	321	131
20	Wages	$8,665,190	$3,660	$545,358	$28,385	$398,704	$79,616	$300,176	$1,512,164	$338,181	$1,555,632	$257,711	$79,296
	Boys under 16 years—												
21	Average number	206		3		7	8	24	34	15	22	1	8
22	Wages	$46,434		$964		$1,605	$2,500	$3,278	$10,271	$2,968	$5,726	$69	$1,095
	All other wage-earners—												
23	Average number	2,240		151	3	148	124	103	247	88	494	51	17
24	Wages	$1,061,194		$93,002	$1,687	$64,135	$51,857	$35,327	$137,593	$32,990	$226,584	$28,664	$6,508
	Average number of wage-earners at specified daily rates of pay:												
	Engineers—												
25	$0.50 to $0.74	1											
26	$0.75 to $0.99	5							1				
27	$1.00 to $1.24	11				1		2			1	1	
28	$1.25 to $1.49	17		1		3	1				1		
29	$1.50 to $1.74	53				3	1	2	7	5	7	1	
30	$1.75 to $1.99	89	1	1		3	1		8	10	19	1	2
31	$2.00 to $2.24	225		5		30			29	15	46	3	3
32	$2.25 to $2.49	96		7		6	1	1	11		26	1	
33	$2.50 to $2.74	93		1	2	3	1	1	3	2	43	3	1
34	$2.75 to $2.99	20		2					6		7	1	1
35	$3.00 to $3.24	37		12	1	1		2	1	1	6		1
36	$3.25 to $3.49	3							1		1		1
37	$3.50 to $3.74	1					1				1	1	
38	$3.75 to $3.99	4					3						
	Firemen—												
39	$0.50 to $0.74	3											
40	$0.75 to $0.99	7				1	1	2			1		
41	$1.00 to $1.24	6				1		1		1			
42	$1.25 to $1.49	18						4	1				
43	$1.50 to $1.74	25					1	1	6	4	2		
44	$1.75 to $1.99	33				1			11		2		
45	$2.00 to $2.24	32				3	3	2	2	1	4		1
46	$2.25 to $2.49	9					3				1		1
47	$2.50 to $2.74	23		1					5	1	1	1	1
48	$2.75 to $2.99	4									2		
49	$3.00 to $3.24	2											
50	$3.25 to $3.49	2								2			
	Machinists, blacksmiths, carpenters, and other mechanics—												
51	$0.50 to $0.74	1											
52	$0.75 to $0.99	9								2			
53	$1.00 to $1.24	18				2	1			5		1	
54	$1.25 to $1.49	25		1		2	1	1	1	3	1		
55	$1.50 to $1.74	73				8		1	10	8	6		
56	$1.75 to $1.99	85				6	2	3	22	2	8	3	
57	$2.00 to $2.24	199		4		8		4	44	11	18	5	1
58	$2.25 to $2.49	107		1		6	4		31		22		1
59	$2.50 to $2.74	185		3	1	5	4	1	33	1	61	2	2
60	$2.75 to $2.99	172		1		14	1	3	60	1	41		1
61	$3.00 to $3.24	156		12	1	14		21	4	12	34	3	1
62	$3.25 to $3.49	38						4		11	1	13	5
63	$3.50 to $3.74	15		2		1		3			2	1	
64	$4.00 to $4.24	9		4							1		
	Quarrymen and stonecutters—												
65	$0.50 to $0.74	52						7		5	2	1	
66	$0.75 to $0.99	350			1			59		19	2		
67	$1.00 to $1.24	958				9		106	2	3	37		
68	$1.25 to $1.49	1,583	3	2		36	15	128	47	230	86		25
69	$1.50 to $1.74	2,655	6	2		222	107	29	573	195	389	7	27
70	$1.75 to $1.99	2,648		56		177	16	2	584	17	609	4	15
71	$2.00 to $2.24	1,758		210		64	4		187	5	449	117	27
72	$2.25 to $2.49	435		54	6	8	1	22	101		131	11	9
73	$2.50 to $2.74	811		253	31	9		4	136	1	174	17	1
74	$2.75 to $2.99	1,163		17		77		22	217		238		
75	$3.00 to $3.24	1,318		24		47		87	351	48	202	15	1
76	$3.25 to $3.49	428				17		36	28	46	8	129	26
77	$3.50 to $3.74	175		1				28	9	46	5	17	
78	$3.75 to $3.99	18									1	3	
79	$4.00 to $4.24	110		89				8		1			
80	$4.25 and over	9											

[1] Includes operators distributed as follows: Arizona, 1; Idaho, 2; Indian Territory, 1; Nevada, 1.

SUMMARY, BY STATES AND TERRITORIES: 1902.

Montana.	New Hampshire.	New Jersey.	New York.	North Carolina.	Oregon.	Pennsylvania.	Rhode Island.	South Carolina.	Texas.	Utah.	Vermont.	Virginia.	Washington.	Wisconsin.	All other states and territories.[1]	
3	51	49	22	30	10	44	19	15	8	5	74	17	9	18	5	1
3	49	46	22	27	10	43	19	14	8	5	68	17	8	15	5	2
2	25	14	8	14	5	25	9	5	6	3	29	10	3	2	4	3
1	13	14	7	10	3	8	8	3	1	2	32	3	1	2	1	4
...	11	18	7	2	2	8	2	6	1	...	8	4	4	11	...	5
...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	...	6
1	87	92	47	31	3	58	54	41	8	...	128	21	20	30	2	7
$1,420	$65,648	$64,508	$42,942	$23,578	$2,500	$60,677	$55,310	$32,841	$8,400	...	$104,655	$12,904	$11,948	$31,284	$3,120	8
...	7	10	5	2	1	14	7	4	1	...	3	1	1	10	...	9
...	$4,375	$10,525	$4,006	$2,270	$1,000	$28,520	$15,650	$4,300	$1,800	...	$4,000	$800	$865	$15,456	...	10
1	62	61	30	24	2	32	23	30	6	...	80	17	16	12	2	11
$1,420	$52,618	$43,185	$30,299	$18,625	$1,590	$26,009	$21,208	$23,068	$5,400	...	$77,645	$11,484	$9,631	$9,906	$3,120	12
...	18	21	12	5	...	12	24	7	1	...	36	3	3	8	...	13
...	$8,655	$10,798	$8,637	$2,683	...	$6,348	$18,452	$5,473	$1,200	...	$23,010	$670	$1,452	$5,922	...	14
21	1,219	947	655	615	35	703	638	815	56	1	1,505	409	137	391	14	15
$26,488	$791,196	$433,166	$357,329	$222,868	$25,451	$311,720	$421,608	$351,046	$41,184	$330	$968,950	$190,822	$95,949	$295,495	$11,620	16
3	154	86	57	51	3	58	83	71	6	...	150	36	23	33	2	17
$3,738	$99,251	$54,417	$37,162	$24,074	$2,025	$37,697	$56,016	$48,896	$4,869	...	$106,944	$17,460	$14,390	$19,833	$2,000	18
16	1,024	780	553	454	23	577	446	661	40	1	1,139	384	106	289	12	19
$21,250	$677,549	$346,544	$300,518	$173,794	$17,148	$275,627	$317,577	$282,492	$31,847	$330	$703,110	$162,296	$76,946	$189,584	$9,690	20
...	8	6	12	8	...	1	...	22	1	...	20	5	...	1	...	21
...	$2,323	$1,218	$2,927	$1,300	...	$240	...	$3,158	$150	...	$5,442	$1,060	...	$150	...	22
2	33	75	33	102	9	67	107	61	9	...	196	44	8	68	...	23
$1,500	$12,073	$30,987	$16,722	$22,800	$6,294	$28,156	$48,016	$16,500	$4,318	...	$144,464	$19,516	$4,613	$26,908	...	24
			1													25
			1			1						1	1			26
				1								4		1		27
		1		3		2						3		2		28
	4	3	1	2		5	1	1			2	4		1		29
	13	8	2	1		1	10				4	1	1	2		30
	18	10	7	2	1	7	13	6	1		24	2	1	2		31
	11	7	4		2	1	1		1		13		3			32
	3	3	1			6	1	10			6					33
		1	1										1			34
	1	4	1			2								3	1	35
																36
1																37
			1													38
				1				2								39
								1						1		40
				1							1	1				41
		2		8								1	1	1		42
	1	3	2				2				2	1				43
	1	1	2			9	1				3	2				44
	1	3	3			1		4			3		1			45
	1	1	1											1		46
		2						10	1							47
		1											1			48
	1										1					49
																50
														1		51
			2	1				1				1	1	1		52
	3			5			1									53
				3			1	4			2	2	1	2		54
	15	6	5	6			1	2			2	1	2			55
	16	5	2	1		1	1	1	1		6	2	2			56
	14	12	8	8		7	12	10			19	4	1	9		57
	11	3	1			3	6				10	4	2	2		58
	12	6	1	8		6	16	1	1		17	2		2		59
	16	2	1			5	13				12			1		60
	12	2	2			1	3	14			20		1	1		61
1			2								1					62
			1						1				3		1	63
1								1			2					64
			1	27				9								65
		1	5	29			3	208			2	21				66
	1	64	1	286	1	10	1	246			17	171				67
	33	800	137	28		219	26	38			84	129		7		68
	174	824	109	36	3	183	45	23	1	1	132	24		43	1	69
	350	16	82	5		60	52		13		401	3	4	102		70
	67	29	144	21	8	21	53		1		258		52	38	3	71
	15		2		3	7	8		1		29		24	2	1	72
	24	84		19	1	6	26		10		7	10	7	22	3	73
	109		18			7	96				175			27		74
5	149	11	13	4	4	5	118	84			63	25	6	25	1	75
	27					18	10	40			18		2	23		76
6	5	1	9			10	3	18	13		2	1	3		3	77
	1		2			1	2				1		7			78
	6				3		1		1				1			79
5	3						1									80

TABLE 42.—SILICEOUS CRYSTALLINE ROCKS—DETAILED

		United States.	Arkansas.	California.	Colorado.	Connecticut.	Delaware.	Georgia.	Maine.	Maryland.	Massachusetts.	Minnesota.	Missouri.
	Average number of wage-earners at specified daily rates of pay—Continued.												
	Boys under 16 years—												
81	Less than $0.50	36		1				14		4	1	1	2
82	$0.50 to $0.74	56				1		9	3	5	4		4
83	$0.75 to $0.99	49				6		1	13	4	8		1
84	$1.00 to $1.24	59		1			8		16	1	9		1
85	$1.25 to $1.49	5		1					1	1			
86	$1.50 to $1.74	1							1				
	All other wage earners—												
87	Less than $0.50	1											
88	$0.50 to $0.74	20								1	1		
89	$0.75 to $0.99	153				1			1	3	9		
90	$1.00 to $1.24	230		1		19	18	63	1	1	16		6
91	$1.25 to $1.49	448		1		47	40	10	7	80	93	2	7
92	$1.50 to $1.74	739		3		74	59		119	1	296	19	3
93	$1.75 to $1.99	190		1	3		7		16	1	38	7	
94	$2.00 to $2.24	269		145		7			33	1	21	20	
95	$2.25 to $2.49	45							24		6		
96	$2.50 to $2.74	26							5		4		1
97	$2.75 to $2.99	5							2		1		
98	$3.00 to $3.24	93							8		4	2	
99	$3.25 to $3.49	9											
100	$3.50 to $3.74	5											
101	$3.75 to $3.99	1									1		
102	$4.00 to $4.24	6							1		1	1	
	Average number of wage-earners employed during each month:												
	Men 16 years and over—												
103	January	12,289	10	810	25	633	84	117	2,080	610	2,388	370	66
104	February	12,665	10	789	26	402	101	164	2,299	592	2,343	417	78
105	March	14,755	10	782	46	504	261	353	2,460	774	2,614	422	109
106	April	18,674	10	884	45	964	342	626	2,934	781	3,568	443	123
107	May	20,138	10	887	45	1,087	460	651	3,115	864	3,885	461	145
108	June	21,362	10	893	51	1,239	469	709	3,264	884	3,966	426	148
109	July	22,433	10	952	60	1,371	486	754	3,310	933	4,133	415	248
110	August	22,002	10	946	60	1,387	530	946	3,400	931	3,922	411	254
111	September	22,092	10	992	54	1,360	387	865	3,255	864	3,942	418	252
112	October	21,788	10	1,041	50	1,189	400	912	3,091	859	3,994	414	260
113	November	19,147	10	1,046	50	828	346	826	2,519	795	3,539	387	205
114	December	15,615	10	982	40	728	258	700	1,899	747	2,683	372	164
	Boys under 16 years—												
115	January	153		2		7		19	26	8	20		2
116	February	163		2		8		22	32	8	20		2
117	March	178		2		6	9	23	28	13	18		3
118	April	218		2		9	9	24	32	17	23		3
119	May	212		2		10	9	23	34	17	24	2	4
120	June	227		3		10	9	26	38	17	26	2	4
121	July	245		4		10	10	29	38	17	27	2	13
122	August	241		4		8	10	29	41	17	23	2	13
123	September	239		4		5	10	25	41	19	23	2	13
124	October	231		4		4	10	25	38	19	22	2	14
125	November	201		4		1	10	23	33	15	20		13
126	December	171		3		3	10	20	27	13	19		12
	Miscellaneous expenses:												
127	Total	$810,206	$945	$39,232	$2,930	$31,859	$19,688	$32,588	$66,483	$43,856	$215,745	$12,028	$8,256
128	Royalties and rent of quarrying plant.	$194,892	$760	$18,039	$65	$8,308	$7,598	$8,701	$6,106	$11,430	$79,471	$1,502	$5,350
129	Rent of offices, taxes, insurance, interest, and other sundries.	$615,314	$185	$21,193	$2,865	$23,551	$12,090	$23,887	$60,377	$32,426	$136,274	$10,526	$2,906
130	Cost of supplies and materials	$2,493,065	$650	$115,429	$4,720	$118,231	$18,126	$189,278	$217,549	$107,435	$509,702	$52,273	$32,104
	Value of product:												
131	Total	$18,257,944	$12,115	$1,137,679	$66,023	$812,141	$276,743	$843,778	$2,360,450	$758,203	$3,451,307	$478,980	$157,708
	Rough—												
132	Building	$2,175,082	$50	$220,988	$47,752	$117,802	$20,640	$40,150	$485,217	$139,856	$400,842	$17,154	$3,009
133	Monumental	$1,714,156	$215	$34,992	$8,770	$28,862		$45,814	$52,836	$10,525	$412,172	$80,656	$27,051
134	Other uses	$543,911		$8,455		$3,929	$4,593	$12,330	$12,730	$4,150	$123,809	$2,700	
	Dressed—												
135	Building	$4,859,750	$600	$133,574	$1,800	$200,262	$2,107	$89,213	$1,135,803	$323,239	$965,342	$181,089	$29,283
136	Monumental	$2,284,755		$43,855	$1,513	$96,899		$18,565	$155,305	$17,500	$581,872	$151,825	$2,185
	Crushed—												
137	Concrete	$734,561		$116,400		$51,552	$10,924	$7,047	$1,784	$54,704	$97,584	$1,700	$19,241
138	Railroad ballast, etc	$574,780	$2,000	$13,861		$2,250	$67,291	$10,122	$900	$26,535	$40,735	$1,625	
139	Roadmaking, macadam, etc.	$1,902,439	$9,000	$135,842	$3,750	$238,261	$41,237	$26,741	$8,070	$74,522	$278,656	$12,635	$18,803
140	Paving blocks	$1,523,776		$144,160		$34,579	$9,675	$151,779	$354,530	$30,521	$358,308	$3,280	$42,350
141	Curbing	$823,846	$75	$28,205		$23,080	$4,701	$317,164	$112,290	$55,955	$111,184	$15,340	$6,900
142	Flagging	$52,880		$495		$571		$12,883	$10,238	$7,301	$15,614	$480	
143	Rubble	$500,176	$175	$24,635	$2,438	$8,468	$61,096	$80,870	$6,318	$9,055	$224,187	$6,695	
144	Riprap	$319,158		$48,099		$32,426	$53,940		$13,077	$2,260	$26,460	$1,200	$3,451
145	Other uses	$248,671		$174,118		$400	$539	$21,141	$11,172	$16,790	$4,892		$5,435
	Power:												
146	Total horsepower	46,986	20	1,241	108	5,948	1,153	718	5,325	1,710	8,672	1,636	718
	Owned—												
	Engines—												
	Steam—												
147	Number	950	1	14	2	84	12	36	134	19	62	32	22
148	Horsepower	44,180	20	1,210	40	5,930	1,043	712	4,928	1,697	8,458	665	718
	Gas or gasoline—												
149	Number	26		1	1	2			4	2	1	6	
150	Horsepower	275		6	3	18			27	13	12	90	
	Water wheels—												
151	Number	15							2			2	
152	Horsepower	1,506							300			543	
	Other power—												
153	Number	19		1			5		3		3	3	
154	Horsepower	510		10			110		70		167	33	
	Rented—												
155	Electric, horsepower	471		15	65			6			35	305	
156	Other power, horsepower.	35											
	Electric motors owned—												
157	Number	23		1				1	5	1	2	1	
158	Horsepower	442		20				20	85	15	30	15	
159	Supplied to other establishments, horsepower.	25							25				

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[1] Includes operators distributed as follows: Arizona, 1; Idaho, 2; Indian Territory, 1; Nevada, 1.

SUMMARY, BY STATES AND TERRITORIES: 1902—Continued.

Montana.	New Hampshire.	New Jersey.	New York.	North Carolina.	Oregon.	Pennsylvania.	Rhode Island.	South Carolina.	Texas.	Utah.	Vermont.	Virginia.	Washington.	Wisconsin.	All other states and territories.¹	
				8				5								81
	1	5						17	1		1	1		1		82
	1		9								2	4				83
	6	1	3			1					12					84
											2					85
																86
													1			87
							1	16					1			88
	2		2	102		2	19	8			1	3				89
	21	4				4	2	10			17	12		35		90
	3	45	7			45	3	16			11	2		1		91
	5	17	22			14	58	4	9		19			17		92
	2	8				2	7	5			27	26		10		93
	1				3		10	3			19		1	2		94
	1				6		3	1			3		1			95
2						1	1				7	1		4		96
											3					97
											79					98
											2					99
		1	2								2					100
																101
							5									102
12	456	216	357	270	18	510	451	762	48		1,266	282	27	260	2	103
16	550	300	305	540	24	498	475	762	52		1,276	259	27	258	2	104
23	694	469	498	445	28	554	596	817	72		1,330	385	44	271	14	105
27	1,222	976	619	705	37	688	599	848	51		1,404	493	71	289	2	106
27	1,470	1,062	705	795	43	770	734	768	49	2	1,494	550	95	488	16	107
26	1,420	1,101	770	767	44	850	716	821	50	2	1,580	576	119	457	22	108
27	1,544	1,208	779	722	39	825	750	821	52	2	1,619	574	230	484	21	109
24	1,582	1,320	808	779	41	870	760	925	55	3	1,640	569	186	481	21	110
24	1,550	1,277	775	737	40	858	715	876	56	3	1,672	506	168	408	18	111
24	1,551	1,225	748	687	38	782	672	862	57		1,667	518	230	469	17	112
11	1,489	1,123	712	543	35	713	628	645	56		1,606	444	224	455	22	113
11	1,014	872	640	500	32	572	570	579	62		1,416	412	190	360	12	114
	2	2	8	7		1		22	1		19	5		2		115
	2	2	8	6		1		25	1		19	5		2		116
	2	3	9	9		1		25	1		19	5		2		117
	11	5	13	8		1		23	1		20	5		2		118
	11	6	14	6		1		23	1		20	5		1		119
	11	7	14	9		1		23	1		20	5		1		120
	11	8	13	10		1		24	1		21	5		1		121
	11	8	13	8		1		25	1		21	5		1		122
	11	9	13	11		1		25	1		21	5				123
	11	9	13	8		1		25	1		20	5				124
	11	8	13	8		1		13	1		19	5				125
	2	5	13	6		1		13	1		21	5				126
$278	$26,719	$53,135	$28,257	$16,463	$977	$41,056	$22,898	$31,047	$2,304	$63	$70,653	$12,466	$2,644	$26,211	$1,595	127
	$2,372	$13,620	$10,180	$5,585	$600	$25,025	$13,643	$5,488	$1,295		$17,039	$10,163		$622		128
$278	$24,347	$39,515	$18,077	$10,878	$377	$16,031	$9,255	$25,559	$1,009	$63	$53,614	$2,303	$2,644	$25,589	$1,595	129
$2,583	$152,122	$164,562	$94,269	$42,884	$1,496	$128,968	$71,908	$131,771	$5,095	$190	$272,888	$22,290	$21,264	$35,409	$900	130
$77,460	$1,147,097	$948,474	$651,014	$388,750	$58,429	$661,062	$734,623	$598,848	$60,003	$1,479	$1,570,123	$295,046	$117,273	$309,137	$18,000	131
$16,600	$148,579	$70,884	$131,549	$26,490	$3,931	$121,198	$18,798	$79,580	$10,345	$495	$28,845	$21,178	$9,870	$1,160	$800	132
$100	$57,335	$2,940	$1,500	$920	$2,750	$1,650	$111,752	$30,998	$17,145	$554	$756,007	$12,500	$4,504	$16,650		133
	$5,564	$450	$975	$1,250	$1,800	$525	$750	$553,728			$23,896			$600		134
$16,000	$471,537	$43,761	$175,994	$131,525	$5,440	$78,678	$150,767	$71,000	$3,439		$280,567	$28,840	$12,057	$30,958	$7,950	135
$250	$289,400		$7,180	$8,509	$2,000	$450	$458,997	$21,590	$20,084	$450	$433,187	$51,612	$11,953	$118,009	$6,600	136
	$8,012	$115,035	$94,142	$8,206	$1,100	$58,479	$2,500	$35,078				$46,588			$820	137
	$1,750	$59,546	$30,126	$51,080	$1,550	$188,129	$42	$23,510			$3,025	$25,554	$22,971	$25		138
	$15,788	$578,424	$193,435	$4,910	$11,500	$140,166	$12,805	$650			$3,308	$6,133		$86,700		139
	$101,548	$72,404	$6,762	$6,996	$6,400	$14,411	$14,657	$4,547			$2,855	$14,845	$5,000	$114,290		140
$300	$22,528		$827	$79,382		$6,799	$5,478	$7,100			$5,770	$20,796	$10,273		$900	141
	$840		$640	$3,290	$375		$160	$500				$550				142
	$810	$700	$6,874	$6,888	$1,550	$16,709	$9,974	$5,585			$2,000	$26,255	$34,054	$500	$1,400	143
$43,800	$17,056	$4,320	$1,000	$3,676	$813	$7,488	$621				$108	$17,215	$35,788			144
	$3,350			$2,500		$920	$4,289	$540			$1,815	$1,000				145
50	2,591	3,157	2,393	1,095	135	2,228	1,406	890	130		2,645	868	650	1,691	55	146
3	89	66	35	32	4	50	39	30	4		72	32	13	22	1	147
50	2,497	3,087	2,333	1,095	129	2,188	1,344	910	130		2,467	868	650	1,210	80	148
	2		1		1	1	1							3		149
	27		15		6	25	12							21		150
	1					1					5			4		151
	10					15					178			460		152
		1					2	1								153
		50					50	20								154
		20													25	155
			35													156
	5										5		1			157
	75										100		22			158
																159

TABLE 43.—SLATE—DETAILED SUMMARY, BY STATES: 1902.

	United States.	Maine.	Maryland.	New York.	Pennsylvania.	Vermont.	Virginia.	All other states.[1]
Number of quarries	199	7	6	11	91	76	4	4
Number of operators	174	7	6	11	84	58	4	4
Character of ownership:								
Individual	27	1		2	9	14	1	
Firm	87		1	6	43	35	2	
Incorporated company	60	6	5	3	32	9	1	4
Salaried officials, clerks, etc.:								
Total number	437	22	10	17	259	97	15	17
Total salaries	$334,879	$16,999	$4,520	$24,645	$180,885	$78,412	$11,400	$18,228
General officers—								
Number	66	1	3	8	47	3		4
Salaries	$64,735	$1,600	$900	[illegible]	$43,215	$7,000		$5,040
Superintendents, managers, foremen, surveyors, etc.—								
Number	267	19	4	7	145	71	11	10
Salaries	$207,915	$14,324	$2,400	[illegible]	[illegible]	$56,597	$9,170	$11,018
Clerks—								
Number	104	2	3	2	67	23	4	3
Salaries	$62,209	$1,075	$1,220	[illegible]	[illegible]	$14,815	$2,230	$2,170
Wage-earners:								
Total average number	5,922	217	145	145	[illegible]	[illegible]	257	120
Total wages	$3,177,489	$110,818	$72,179	[illegible]	[illegible]	$874,263	$97,645	$73,818
Engineers, firemen, and other mechanics—								
Average number	505	19	9	12	276	163	12	22
Wages	$271,796	$9,842	$5,049	[illegible]	[illegible]	$62,527	$6,541	$15,667
Quarrymen and stonecutters—								
Average number	3,656	131	87	129	1,920	1,198	106	74
Wages	$2,136,805	$66,549	$49,005	$62,362	$1,218,390	$647,328	$70,077	$33,304
Boys under 16 years—								
Average number	169		5	2	113	38	7	2
Wages	[illegible]		$1,089	$475	$24,304	[illegible]	$648	$250
All other wage-earners—								
Average number	1,592	67	44	2	[illegible]	[illegible]	132	22
Wages	$713,494	$34,427	$17,036	$1,167	[illegible]	$154,852	$20,379	$14,537
Average number of wage-earners at specified daily rates of pay:								
Engineers—								
$0.75 to $0.99	2				2			
$1.00 to $1.24	20				11	4	3	2
$1.25 to $1.49	61	1	1		50	6		1
$1.50 to $1.74	48	2	2	1	37	5		3
$1.75 to $1.99	38	1		8	10	18	1	
$2.00 to $2.24	61	2	3	2	23	31		
$2.25 to $2.49	7		1		1	5		
$2.50 to $2.74	16				6	7		4
$2.75 to $2.99	1							1
$3.00 to $3.24	4				2		1	1
$3.25 to $3.49	1				1			
Firemen—								
$1.00 to $1.24	4				2	1	1	
$1.25 to $1.49	11				11			
$1.50 to $1.74	29	3			23	1	1	1
$1.75 to $1.99	18	1			14	1	2	
$2.00 to $2.24	13	1	1		11			
$2.25 to $2.49	3				1	2		
$2.50 to $2.74	5				1	4		
$2.75 to $2.99	1					1		
$3.25 to $3.49	1							
Machinists, blacksmiths, carpenters, and other mechanics—								
$1.25 to $1.49	6				6			
$1.50 to $1.74	17				16		1	
$1.75 to $1.99	22	1			11	4	1	
$2.00 to $2.24	29	1	1	1	20	6		
$2.25 to $2.49	27	2			20	4	1	
$2.50 to $2.74	13				4	2		6
$2.75 to $2.99	3				2	1		
$3.00 to $3.24	5				1	3		
$3.25 to $3.49	2				1	1		
$3.50 to $3.74	2							2
$4.25 and over	1							
Quarrymen and stonecutters—								
$0.50 to $0.74	3						3	
$0.75 to $0.99	7						6	1
$1.00 to $1.24	127					25	81	5
$1.25 to $1.49	180	[illegible]	5	2	84	78	4	7
$1.50 to $1.74	588	71	3	11	276	213	11	10
$1.75 to $1.99	546	18	7	78	218	291		
$2.00 to $2.24	1,260	26	71	33	565	157	26	32
$2.25 to $2.49	600	7	1	5	458	146	14	8
$2.50 to $2.74	363				274	14	20	8
$2.75 to $2.99	112				111	1		
$3.00 to $3.24	86	1			74			11
Boys under 16 years—								
Less than $0.50	7				1		5	1
$0.50 to $0.74	62		4		86	3	2	1
$0.75 to $0.99	75			2	16	27		
$1.00 to $1.24	20				12	8		
$1.25 to $1.49	1		1					
All other wage-earners—								
$0.50 to $0.74	5				3			
$0.75 to $0.99	17				5	1	11	
$1.00 to $1.24	129	21			67	5	96	
$1.25 to $1.49	690		39		607	28	15	
$1.50 to $1.74	460	8	5		216	238		7
$1.75 to $1.99	75	11		1	52	12		
$2.00 to $2.24	96	19		1	62	15		
$2.25 to $2.49	32				25			7
$2.50 to $2.74	32	6			18			8
$2.75 to $2.99	14	2			12	1		
$3.00 to $3.24	10				8	2		
$3.50 to $3.74	2				2			

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[1] Includes operators distributed as follows: Arkansas, 1; California, 1; Georgia, 1; New Jersey, 1.

TABLE 43.—SLATE—DETAILED SUMMARY, BY STATES, 1902—Continued.

	United States.	Maine.	Maryland.	New York.	Pennsylvania.	Vermont.	Virginia.	All other states.
Average number of wage-earners employed during each month:								
Men 16 years and over—								
January	5,109	185	137	110	[illegible]	1,411	[illegible]	81
February	5,111	190	129	102	[illegible]	[illegible]	[illegible]	88
March	5,302	[illegible]	113	92	[illegible]	[illegible]	[illegible]	94
April	5,731	[illegible]	129	[illegible]	[illegible]	1,610	[illegible]	101
May	[illegible]	227	140	158	[illegible]	[illegible]	[illegible]	112
June	5,967	237	152	[illegible]	[illegible]	[illegible]	260	117
July	6,120	221	148	157	[illegible]	[illegible]	230	[illegible]
August	6,176	220	148	160	[illegible]	[illegible]	[illegible]	[illegible]
September	6,167	229	141	163	[illegible]	[illegible]	204	[illegible]
October	6,047	236	149	157	[illegible]	[illegible]	202	[illegible]
November	5,781	241	152	146	[illegible]	1,577	220	115
December	5,496	205	121	143	3,284	[illegible]	209	[illegible]
Boys under 16 years—								
January	[illegible]	....	1	2	137	7	5	1
February	[illegible]	....	1	2	[illegible]	[illegible]	[illegible]	1
March	[illegible]	....	[illegible]	2	[illegible]	[illegible]	7	1
April	[illegible]	....	5	2	[illegible]	[illegible]	6	1
May	[illegible]	....	5	2	[illegible]	[illegible]	8	1
June	[illegible]	....	6	2	117	4	8	1
July	[illegible]	....	6	2	[illegible]	[illegible]	8	1
August	[illegible]	....	6	2	[illegible]	[illegible]	8	1
September	[illegible]	....	6	2	119	[illegible]	8	1
October	[illegible]	....	6	2	121	[illegible]	8	1
November	[illegible]	....	6	2	112	[illegible]	8	1
December	[illegible]	....	[illegible]	2	[illegible]	7	6	1
Miscellaneous expenses:								
Total	[illegible]	[illegible]	[illegible]	$8,129	[illegible]	[illegible]	[illegible]	$2,445
Royalties and rent of quarrying plant	[illegible]	[illegible]	$1,967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rent of offices, taxes, insurance, interest, and other sundries	[illegible]	$12,903	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cost of supplies and materials	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$162,410	[illegible]	[illegible]
Product:								
Total value	[illegible]	[illegible]	[illegible]	$126,718	[illegible]	[illegible]	[illegible]	[illegible]
Roofing slate:								
Quantity, squares	[illegible]	[illegible]	[illegible]	21,165	[illegible]	[illegible]	[illegible]	14,000
Value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$71,500
Mill stock value	[illegible]	$22,726	$629	$10,400	[illegible]	[illegible]	....	....
Power:								
Total horsepower	[illegible]	800	[illegible]	1,462	[illegible]	[illegible]	[illegible]	[illegible]
Owned—								
Steam engines—								
Number	[illegible]	28	23	21	[illegible]	[illegible]	[illegible]	6
Horsepower	24,649	800	[illegible]	1,142	[illegible]	[illegible]	[illegible]	250
Water wheels—								
Number	5	....	....	3	....	....	....	2
Horsepower	[illegible]	....	....	[illegible]	....	....	....	[illegible]
Other power—								
Number	4	....	....	1	....	....	[illegible]	....
Horsepower	[illegible]	....	....	[illegible]	....	....	[illegible]	....
Rented—								
Electric, horsepower	[illegible]	....	[illegible]	....	[illegible]	[illegible]	....	....
Electric motors owned:								
Number	[illegible]	....	....	....	....	....	....	[illegible]
Horsepower	[illegible]	....	....	....	....	....	....	[illegible]

CEMENT

CEMENT.

By Story B. Ladd.

Hydraulic cements are of three kinds, Portland or artificial cement, natural-rock cement, and Pozzuolana or slag cement. The last-named class does not fall within the scope of the mining census, nor does the manufacture of any kind of cement, except as it is associated with the mining or quarrying of the raw material; hence the statistics presented in Tables 1 and 8 include only the Portland and natural-rock cement made by establishments mining or quarrying the raw material, at least in part. In cases where the raw material was manufactured into cement by the operator of the mine or quarry, the statistics include the manufacture, as well as the mining and quarrying, of the raw material; and where a part of the raw material was mined or quarried and a part purchased, the complete mining and manufacturing statistics are included, because it was impossible to differentiate the statistics chargeable to the purchased material from those pertaining to material mined or quarried.

The comparative statistics from 1850 to 1902, inclusive, are shown in Table 1.

Table 1.—*Comparative summary: 1850 to 1902.*

	1902	1889	1880	1870[1]	1860[1]	1850[1]
Number of mines or quarries	101	(2)	28	(2)	(2)	(2)
Number of operators	93	(2)	(2)	[3]45	[3]11	[3]35
Salaried officials, clerks, etc.:						
Number	913	(2)	(2)	(2)	(2)	(2)
Salaries	$1,087,514	(2)	(2)	(2)	(2)	(2)
Wage-earners:						
Average number	13,041	(2)	2,102	1,632	710	407
Wages	$6,328,852	(2)	$750,367	$631,193	$296,160	$117,924
Contract work	$10,627	(2)	(2)	(2)	(2)	(2)
Miscellaneous expenses	$1,665,520	(2)	(2)	(2)	(2)	(2)
Cost of supplies and materials	$9,098,225	(2)	$700,163	$778,192	$262,920	$238,157
Product:[4]						
Quantity, barrels	24,655,920	[5]7,000,000	2,072,943	(2)	(2)	(2)
Value	$21,268,598	[5]$5,000,000	$1,852,707	$2,033,893	$767,080	$509,110

[1] From Census Report on Manufactures.

[2] Not reported.

[3] Establishments.

[4] The United States Geological Survey reports 25,753,504 barrels, valued at $25,366,380, which includes all manufactured cement. The Census reports only the product of operators mining, quarrying, or excavating raw material.

[5] Estimate in Eleventh Census Report on Mining Industries, page xv.

The growth of the industry has been very great. The increase of production in 1889 over 1880 was nearly 240 per cent, and the increase in 1902 over 1889 was more than 250 per cent.

In 1902 there were 93 operators, of whom 4 were individuals, 6 were firms, and 83 were incorporated companies, as shown by Table 8, a detailed summary of the statistics. Of the individual operators, 3 were located in New York and 1 in Minnesota, and of the firms, 4 were in New York and 1 each in Maryland and Minnesota. The 83 corporations, constituting 89.2 per cent of the operators and owning 91 establishments, or 90.1 per cent of the whole, produced 98.3 per cent of the product. All of the Portland cement was made by incorporated companies. The statistics for the present census are the most complete that have ever been published. At the Eleventh Census no statistics in regard to cement production were reported in connection with the mining census, except the estimated quantity and value of the cement product, 7,000,000 barrels, having a total value of $5,000,000.

Capital stock of incorporated companies.—Table 2 presents in detail the capitalization of incorporated companies.

The state of Pennsylvania led both in number of companies and in capital invested, as represented by the par value of stocks and bonds issued, reporting 39.1 per cent of the entire par value. New York, with 13 corporations, ranked second in number of companies, and Michigan was third, with 10 companies. One company operating in Ohio also owns and operates a plant in Indiana; 1 company operating in Indiana also owns and operates a plant in Kentucky; 1 company in Pennsylvania operates 2 plants in that state, and another company in Pennsylvania operates 3 plants in that state and 1 in Indiana. In the case of 1 limestone company in Michigan and 1 in New York, producing cement as a minor product, the capitalization is reported in connection with the limestone industry. Two companies—1 in Alabama and 1 in Michigan—did not report capitalization; the former was an English corporation, and the latter was engaged extensively in other business, cement being but a small part of the total.

TABLE 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Illinois.	Indiana.	Maryland	Michigan	New York.	Ohio.	Pennsylvania	Virginia.	All other states.
Number of incorporated companies	83	6	7	3	10	13	7	14	3	[1]20
Number reporting capitalization	81	6	7	3	9	13	7	14	3	[2]19
Capital stock and bonds issued	$55,649,870	$2,056,500	$1,401,800	$381,200	$8,910,720	$8,424,200	$2,156,100	$21,765,350	$1,474,000	$9,080,000
Capital stock										
Total authorized—										
Number of shares	1,088,893	33,700	19,780	3,500	565,000	70,850	28,000	255,000	11,000	102,063
Par value	$50,558,500	$1,520,000	$1,238,000	$300,000	$7,450,000	$7,245,000	$2,480,000	$19,650,000	$1,050,000	$9,625,500
Total issued—										
Number of shares	995,345	33,700	19,362	3,422	496,492	63,772	22,881	252,277	10,640	92,799
Par value	$46,932,170	$1,520,000	$1,216,800	$292,200	$6,764,920	$6,537,200	$1,968,100	$18,852,350	$1,062,000	$8,718,600
Dividends paid	$1,209,667	$26,231	$52,634		$137,069	$70,000	$95,586	$556,020		$272,127
Common—										
Authorized—										
Number of shares	955,193	33,700	19,780	3,500	515,000	44,100	23,000	212,800	11,000	92,313
Par value	$42,003,000	$1,520,000	$1,238,000	$300,000	$6,950,000	$4,570,000	$1,980,000	$15,695,000	$1,050,000	$8,700,000
Issued—										
Number of shares	865,222	33,700	19,362	3,422	446,492	37,022	18,581	211,954	10,640	84,049
Par value	$38,653,520	$1,520,000	$1,216,800	$292,200	$6,264,920	$3,862,200	$1,538,100	$15,053,700	$1,062,000	$7,843,600
Dividends paid	$958,367	$26,231	$52,634		$102,069	$52,000	$71,586	$381,720		$272,127
Preferred—										
Authorized—										
Number of shares	133,700				50,000	26,750	5,000	42,200		9,750
Par value	$8,555,500				$500,000	$2,675,000	$500,000	$3,955,000		$925,500
Issued—										
Number of shares	130,123				50,000	26,750	4,300	40,323		8,750
Par value	$8,278,650				$500,000	$2,675,000	$430,000	$3,798,650		$875,000
Dividends paid	$251,300				$35,000	$18,000	$24,000	$174,300		
Bonds										
Authorized—										
Number	15,217	3,130	200	190	2,700	2,117	390	4,270	730	1,440
Par value	$9,578,400	$565,000	$200,000	$85,000	$2,215,000	$2,097,000	$390,000	$3,250,000	$445,000	$331,400
Issued—										
Number	14,159	3,073	185	178	2,642	1,907	188	3,846	700	1,440
Par value	$8,717,700	$536,500	$185,000	$89,000	$2,145,800	$1,887,000	$188,000	$2,913,000	$412,000	$361,400
Interest paid	$316,962	$32,190	$9,250	$5,340	$62,126	$41,076	$6,360	$149,650	$10,000	$970
Assessments levied	$35,396					$35,396				

[1] Includes companies distributed as follows: Alabama, 1; California, 2; Colorado, 1; Georgia, 2; Kansas, 2; Kentucky, 1; Missouri, 1; New Jersey, 2; North Dakota, 1; South Dakota, 1; Texas, 2; Utah, 1; West Virginia, 1; Wisconsin, 2.

[2] Includes companies distributed as follows: California, 2; Colorado, 1; Georgia, 2; Kansas, 2; Kentucky, 1; Missouri, 1; New Jersey, 2; North Dakota, 1; South Dakota, 1; Texas, 2; Utah, 1; West Virginia, 1; Wisconsin, 2.

Dividends to the aggregate amount of $1,209,667 were reported as paid by 31 companies, of which 6 were located in New York, 6 in Pennsylvania, 4 in Indiana, 3 in Michigan, 2 each in Illinois, Kansas, Ohio, and New Jersey, and 1 each in Colorado, South Dakota, Utah, and Wisconsin. Dividends to the amount of $251,300 were paid on preferred stock of a total par value of $3,605,000, by 3 companies in Pennsylvania, 2 in New York, and 1 each in Michigan and Ohio; and dividends aggregating $958,367 were paid on common stock of a total par value of $11,441,910, by 4 companies in Indiana, 4 in New York, 3 in Pennsylvania, 2 each in Illinois, Kansas, Michigan, New Jersey and Ohio, and 1 each in Colorado, South Dakota, Utah, and Wisconsin. The dividends paid averaged 7 per cent on the preferred stock and 8.4 per cent on the common stock of the companies reporting them.

The sum of $35,396 was paid in assessments to 2 companies in New York. Outstanding bonds aggregating $8,717,700 were reported by 34 companies; but the interest reported, amounting to $316,962, was paid by only 25 companies on bonds of a par value of $6,081,700, distributed as follows: Pennsylvania, $2,813,000; Michigan, $1,145,800; New York, $787,000; Illinois, $536,500; Virginia, $400,000; Indiana, $185,000; Ohio, $106,000; Maryland, $89,000; and "all other states," $19,400.

Employees and wages.—Of the $7,416,366 paid for salaries and wages, $1,087,514 was paid to 913 salaried officials, clerks, etc., and $6,328,852 to 13,041 wage-earners. The salaried employees comprised 148 general officers, who received $347,132, an average salary of $2,346; 426 superintendents, managers, foremen, surveyors, etc., who received $491,671, an average of $1,154; and 339 clerks, who received $248,711, an average of $734. Of the 13,041 wage-earners 2,092 were engineers, firemen, and other mechanics, who received $1,324,121; 3,251 were miners or quarrymen and miners' helpers, who received $1,440,029; and 111 were boys under 16 years of age, who received $23,499; the 7,587 other wage-earners received $3,541,203.

Mining below ground was reported in the case of 14 mines or quarries, of which 5 were located in New York, 3 in Maryland, and 1 each in Illinois, Indiana, North Dakota, Ohio, Virginia, and Wisconsin. Boys under 16 years of age were employed in 22 mines—6 in Pennsylvania, 5 in New York, 2 each in Kansas and Virginia, and 1 each in Alabama, California, Georgia, Indiana, Maryland, Texas, and Utah. Of these mines, only 1, located in the state of New York, reports the employment of boys underground.

The variation in the numbers of wage-earners employed at different seasons of the year is shown in Table 8, which gives the average number of men and boys employed during each month. Taking the industry as a whole, the minimum number was employed in February and the maximum in September, with a steady increase from February to September, followed by a slight falling off in the fall and early winter. The increase in the number of wage-earners for December over the number employed in January, 35 per cent, reflects the growth of the industry, which was most marked in Michigan, Illinois, and Indiana.

In addition to asking for the average number of employees and the total amount paid as wages, the schedule called for the number of wage-earners employed at specified daily rates of pay. These statistics are shown in the following table:

TABLE 3.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL OCCUPATIONS.		ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS AND QUARRYMEN.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.	Average number.	Per cent of total.
Total	13,041	100.0	337	100.0	338	100.0	1,417	100.0	3,031	100.0	111	100.0	7,807	100.0
Less than 0.50	37	0.3									37	33.3		
0.50 to 0.74	20	0.2							2	[1]	15	13.5	3	[1]
0.75 to 0.99	192	1.5			2	0.6	1	0.1	54	1.8	38	34.3	97	1.2
1.00 to 1.24	1,099	8.4	9	2.7	31	9.2	70	4.9	350	11.5	19	17.1	620	7.9
1.25 to 1.49	3,849	29.5	39	11.6	27	8.0	120	8.5	1,166	38.5	1	0.9	2,496	32.0
1.50 to 1.74	4,107	31.5	17	5.0	67	19.8	251	17.7	895	29.5	1	0.9	2,876	36.8
1.75 to 1.99	1,632	12.5	26	7.7	86	25.4	214	15.1	327	10.8			979	12.5
2.00 to 2.24	933	7.2	98	29.1	87	25.7	300	21.2	169	5.6			279	3.6
2.25 to 2.49	427	3.3	58	17.2	24	7.1	119	8.4	26	0.9			200	2.6
2.50 to 2.74	433	3.3	42	12.5	5	1.5	190	13.4	32	1.1			164	2.1
2.75 to 2.99	103	0.8	15	4.4	1	0.3	49	3.4	8	0.3			30	0.4
3.00 to 3.24	125	1.0	26	7.7	8	2.4	58	4.1	2	[1]			31	0.4
3.25 to 3.49	47	0.4	3	0.9			32	2.2					12	0.2
3.50 to 3.74	19	0.1					5	0.4					14	0.2
3.75 to 3.99	7	[1]	3	0.9			2	0.1					2	[1]
4.00 to 4.24	7	[1]	1	0.3			5	0.4					1	[1]
4.25 and over	4	[1]					1	0.1					3	[1]

[1] Less than one-tenth of 1 per cent.

Three-fifths of all wage-earners were paid from $1.25 to $1.74 per day, 29.5 per cent receiving from $1.25 to $1.49, and 31.5 per cent from $1.50 to $1.74; of those at lower rates, 8.4 per cent received from $1 to $1.24 and 2 per cent less than $1; while of those at higher rates 12.5 per cent received from $1.75 to $1.99, and 16.1 per cent $2 and over.

Of the total number of wage-earners 3,031, or 23.2 per cent, were miners or quarrymen; of this class, 2,061, or 68 per cent, received from $1.25 to $1.74 per day. Of the 3,031 miners or quarrymen distributed in Table 3 according to daily rates of pay, there were 449, 14.8 per cent of the total number, for whom rates had to be computed, because they were paid by the ton or cubic yard. The total amount paid them was $215,796.

Contract mining or quarrying was reported for 11 mines or quarries, located 3 each in New York, Ohio, and Pennsylvania, and 1 each in California, Michigan, and Utah, at rates ranging from $0.18 to $0.40 per ton, except in the case of 1 mine in Ohio, where the rate was $1.25 per gross ton. In addition, 1 establishment in Michigan reported the excavation of marl by contract at $0.055 per cubic yard.

Contract work.—Contract work for tunneling, shaft sinking, boring test holes, etc., was reported by 3 establishments, 1 each in Kansas, Kentucky, and New York. The number of men so employed was 34, and the amount paid for such contract work was $10,627.

Supplies, materials, and miscellaneous expenses.—The total expenditure reported for supplies and materials was $9,098,226. As cement is marketed in barrels or bags, the containers constitute quite an item of expense. The total amount reported for miscellaneous expenses was $1,665,520; of this amount, $52,905 was paid by 14 operators—4 in Pennsylvania, 3 in Ohio, and 1 each in Kansas, Maryland, Minnesota, New York, Texas, Utah, and Wisconsin—for royalties and rent of mine or quarry and mining plant, and $1,612,615 was expended for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—The primary power employed in the cement industry aggregated 114,092 horsepower, of which 110,650 was owned and 3,442 rented, the latter being electric power. Of the power owned, 93.8 per cent was steampower. Electric motors were employed in the industry of a total capacity of 17,420 horsepower.

Production.—The total production of hydraulic cement by establishments mining or quarrying raw material in whole or in part, was 24,655,360 barrels, valued at $24,268,338. Pennsylvania was the largest producer, reporting 9,360,802 barrels, or 38 per cent of the entire product; this state and New York together reported 57.2 per cent of the total production. Pennsylvania produced 51.3 per cent of the Portland cement, and New York 44.9 per cent of the natural-rock cement.

Of the 101 mines or quarries covered by Tables 1 and 8, 54 manufactured Portland cement only and 37 natural-rock cement only, while 10 produced both Portland and natural-rock cement. The 54 establishments manufacturing only Portland cement produced 14,115,121 barrels, at an aggregate expense of $12,655,189; nearly 90 per cent of this product was reported by 40 establishments in the states of Illinois, Indiana, Michigan, New Jersey, New York, Ohio, and Pennsylvania. Among the 54 mines or quarries producing Portland cement exclusively there were 13—7 in Michigan, 3 in New York, 2 in Ohio, and 1 in Indiana—which reported the manufacture, in the aggregate, of 1,981,415 barrels of Portland cement from marl. The marl mined or excavated by these establishments was reported in some cases in cubic yards and in other cases in tons, the quantity reported being 723,385 cubic yards and 359,277 tons. In Michigan the development of the marl cement industry has been very great; the 7 establishments reporting from that state excavated 655,902 cubic yards and 20,000 tons of marl, and produced 1,167,052 barrels of cement.

The 37 establishments manufacturing only natural-rock cement produced, in the aggregate, 6,954,704 barrels of cement at an aggregate expense of $2,732,514.

The entire hydraulic cement production of the United States for 1902, including cement manufactured by companies not mining or quarrying any portion of the material, is shown in Table 4.

TABLE 4.—CEMENT PRODUCTION: 1902.

CEMENT MANUFACTURED BY—	Number of establishments.	Number of operators.	PRODUCTION.							
			Total.		Portland cement.		Natural-rock cement.		Pozzuolana or slag cement.	
			Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
All establishments	112	102	25,753,504	$25,366,380	17,230,644	$20,864,078	8,044,305	$4,076,630	478,555	$425,672
Establishments mining or quarrying raw material in whole or in part	101	93	24,655,360	24,268,338	16,691,055	20,231,708	7,964,305	4,036,630	....	....
Establishments not mining or quarrying raw material[1]	11	9	1,098,144	1,098,042	539,589	632,370	80,000	40,000	478,555	425,672

[1] Not included in mining census reports, but included in "Mineral Resources of the United States," published by the United States Geological Survey.

Of the 25,753,504 barrels of hydraulic cement of all kinds manufactured in 1902, 66.9 per cent was Portland cement, 31.2 per cent was natural-rock cement, and 1.9 per cent was Pozzuolana, or slag cement. Of the entire production, 24,655,360 barrels, or 95.7 per cent, was the product of establishments that mined or quarried raw material, at least in part; this product included 96.9 per cent of all Portland cement and 99 per cent of all the natural-rock cement manufactured, but none of the Pozzuolana or slag cement. Cement was manufactured from purchased material by 11 establishments. Of these, 4 establishments—1 each in Colorado, Illinois, Ohio, and Pennsylvania—manufactured Portland cement; 1 establishment in Kansas manufactured natural-rock cement; and 6 establishments—2 in Alabama and 1 each in Illinois, Maryland, New Jersey, and Ohio—made Pozzuolana, or slag cement. The 2 establishments in Alabama manufacturing slag cement were owned by the same company, and 1 company in Illinois manufactured both Portland and slag cement.

The growth of the entire cement industry from 1890 to 1902, inclusive, and the imports during the same period are shown in the following table:

TABLE 5.—CEMENT PRODUCTION AND IMPORTS: 1890 TO 1902.

[Compiled from reports of United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	PRODUCTION.								Imports (barrels).
	Total.		Portland cement.		Natural rock cement.		Pozzuolana, or slag cement.		
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	
1890	7,776,616	$6,380,625	335,500	$704,050	7,441,116	$5,676,575	....	....	1,940,186
1891	8,222,792	6,671,137	454,813	967,429	7,767,979	5,703,708	....	....	2,988,313
1892	8,758,621	7,152,750	547,440	1,153,600	8,211,181	5,999,150	....	....	2,440,654
1893	8,002,467	6,262,846	590,652	1,158,138	7,411,815	5,104,708	....	....	2,674,149
1894	8,362,245	5,030,081	798,757	1,383,473	7,563,488	3,646,608	....	....	2,638,107
1895	8,731,401	5,482,254	990,324	1,586,830	7,741,077	3,895,424	....	....	2,997,395
1896	9,513,473	6,473,213	1,543,023	2,424,011	7,970,450	4,049,202	....	....	2,989,597
1897	10,989,463	8,178,283	2,677,775	4,315,891	8,311,688	3,862,392	....	....	2,090,924
1898	[1]12,111,208	9,859,501	3,692,284	5,970,773	8,418,924	3,888,728	(2)	(2)	2,013,818
1899	15,520,445	12,889,142	5,652,266	8,074,371	9,868,179	4,814,771	(2)	(2)	2,108,388
1900	17,231,150	13,283,581	8,482,020	9,280,525	8,383,519	3,728,848	365,611	$274,208	2,386,683
1901	20,068,737	15,786,789	12,711,225	12,532,360	7,084,823	3,056,278	272,689	198,151	940,330
1902	25,753,504	25,366,380	17,230,644	20,864,078	8,044,305	4,076,630	478,555	425,672	1,961,799

[1] Not including 335,000 barrels of Pozzuolana, or slag cement, the value of which was not reported.

[2] Not reported.

[3] Includes cement manufactured by the 11 establishments not mining or quarrying any raw material, and therefore not included in mining census reports. (See Table 4.)

The production of cement has steadily increased throughout the period covered by this table, except in 1892–93. The natural-rock cement production, however, shows no real growth; it reached its maximum in 1899, and the production in 1902, though greater than that in 1901, is less than that in 1892. On the other hand, the growth in the production of Portland cement has been very great; from 1892 to 1902 the rate of yearly growth averaged 40 per cent, ranging from 7.9 per cent in 1892–93 to 73.5 per cent in 1896–97, so that during the decade the output increased more than thirty-fold. Portland cement outstripped natural rock cement in value in 1897, and in quantity in 1900. The imports reached a maximum in 1895; since that year there has been, on the whole, a considerable decrease, the imports for 1902 exceeding very slightly those for 1890. Since 1897, except in 1900, the annual imports have been below the average of the imports for the entire period of thirteen years, and in 1902 they were approximately on a par with the imports for 1890.

Kilns.—The kiln equipment of the 101 establishments included in Table 8 comprised 584 vertical and 451 rotary kilns. As a rule, natural cement rock is calcined in vertical and Portland cement mixtures in rotary kilns; but 3 establishments in New York and 1 in South Dakota reported the use of 47 vertical kilns in the manufacture of Portland cement, and 1 establishment in Minnesota used 5 rotary kilns for natural-rock cement.

Nonproducers.—There were 51 nonproducing cement establishments, of which 20 were new plants in course of erection. The number, distribution, and character of ownership of these establishments are shown in the following table:

TABLE 6.—*Nonproducing mines or quarries: 1902.*

	United States.	Indiana.	Michigan.	New Jersey.	New York.	Ohio.	Pennsylvania.	Virginia.	All other states and Territories.[1]
Number of mines or quarries	51	[4]10	9	3	6	3	5	3	12
New mines or quarries	20		8	2	1	1	4	..	[3]4
Number of operators	49	9	9	3	6	3	5	[2]2	12

[1] Includes 1 mine or quarry each in Arkansas, California, Colorado, Florida, Georgia, Illinois, Kentucky, Massachusetts, Nebraska, New Mexico, Texas, and West Virginia.

[2] One owned by an active establishment operating in Kentucky.

[3] Includes 1 mine or quarry each in Arkansas, California, Georgia, and New Mexico.

[4] One individual owns 2 idle mines or quarries.

Of the 51 nonproducing establishments, 31—10 in Indiana, 5 in New York, 3 in Virginia, 2 in Ohio, and 1 each in Colorado, Florida, Illinois, Kentucky, Massachusetts, Michigan, Nebraska, New Jersey, Pennsylvania, Texas, and West Virginia—were properly "idle establishments." The other 20—8 in Michigan, 4 in Pennsylvania, 2 in New Jersey, and 1 each in Arkansas, California, Georgia, New Mexico, New York, and Ohio—were in course of erection during the year.

There were 44 incorporated companies which reported ownership of nonproducing mines or quarries—24 owning idle establishments and 20 owning the 20 establishments in course of construction. Capitalization was reported by 16 of these companies, distributed as follows: Companies owning idle establishments, 6 in Indiana and 1 each in Michigan, New York, and Ohio, or a total of 9; companies owning establishments in course of construction (or "new establishments"), 3 in Michigan and 1 each in Arkansas, New Jersey, New York, and Pennsylvania, or a total of 7. The statistics of the capitalization of the nonproducing companies reporting capitalization are shown in Table 7.

TABLE 7.—*Capitalization of nonproducing incorporated companies: 1902.*

	Total.	Idle companies.	New companies owning plants in course of construction.
Number of incorporated companies	44	24	20
Number reporting capitalization	16	9	7
Capital stock and bonds issued	$17,547,700	$2,356,700	$15,191,000
Capital stock			
Total authorized—			
Number of shares	545,389	55,889	489,500
Par value	$27,638,900	$5,588,900	$22,050,000
Total issued—			
Number of shares	403,167	23,567	379,600
Par value	$17,147,700	$2,356,700	$14,791,000
Dividends paid	$12,362	$12,362	....
Common—			
Authorized—			
Number of shares	437,389	35,889	401,500
Par value	$19,238,900	$3,588,900	$15,650,000
Issued—			
Number of shares	356,667	18,567	338,100
Par value	$14,072,700	$1,856,700	$12,216,000
Dividends paid	$12,362	$12,362	....
Preferred—			
Authorized—			
Number of shares	108,000	20,000	88,000
Par value	$8,400,000	$2,000,000	$6,400,000
Issued—			
Number of shares	46,500	5,000	41,500
Par value	$3,075,000	$500,000	$2,575,000
Bonds—			
Authorized—			
Number	1,100	....	1,100
Par value	$630,000	....	$630,000
Issued—			
Number	400	....	400
Par value	$400,000	....	$400,000

If the 7 new companies reporting capitalization are representative of all such companies, there has been a marked increase in the average capitalization per company. The 7 new companies reporting capitalization show a total par value of stocks and bonds issued amounting to $15,191,000, or an average of $2,170,143, as compared with an average of $670,480 for the 83 active companies for which capitalization is reported in Table 2.

The following statistics were reported by 9 of the 51 nonproducing mines or quarries—5 in Indiana and 1 each in New Jersey, New York, Michigan, and Pennsylvania:

Summary, nonproducing mines or quarries: 1902.

Number of mines or quarries reporting	9
Salaried officials, clerks, etc.:	
Number	43
Salaries	$52,333
Wage-earners:	
Average number	340
Wages	$214,617
Miscellaneous expenses	$36,047
Cost of supplies and materials	$3,168
Total horsepower	11,137

Of the salaries, $14,380 was paid to 9 general officers; $28,513 to 16 superintendents, managers, foremen, surveyors, etc.; and $9,440 to 18 clerks. Of the wages, $155,849 was paid to 229 engineers, firemen, and other mechanics; $17,458 to 28 miners or quarrymen—26 above ground and 2 below ground—and $41,310 to 83 other wage-earners. The miscellaneous expenses represented the rent of offices, taxes, insurance, interest, and other sundries. The mechanical power was furnished by 26 steam engines, of 8,835 horsepower; 2 gas or gasoline engines, of 12 horsepower; 1 water wheel of 40 horsepower; and 78 electric motors, of 2,300 horsepower.

A detailed summary showing the statistics for cement during 1902 is given in Table 8.

DESCRIPTIVE.

Hydraulic cements are of three general classes:[1]

(1) Portland cement, a compound consisting essentially of lime, silica, and alumina, produced by mixing intimately some form of calcium carbonate with the necessary proportion of clay, calcining the mixture at a high heat, and grinding the resulting clinker to a fine powder. A mixture of Portland cement and sand ground to an extremely fine powder is called sand cement.

(2) Natural-rock cement, produced by calcining at a comparatively low heat a natural product—such as argillaceous limestone—possessing in its composition lime and clay in proportions adapted to form a hydraulic cement, and usually containing also a considerable proportion of magnesia.

(3) Pozzuolana, or slag cement, produced by mixing with slacked lime a natural volcanic scoria or granulated blast furnace slag of suitable composition.

The chemical constituents of the three general classes of hydraulic cement are approximately as follows:

CONSTITUENTS.	Portland.	Natural rock.	Slag.
Lime (per cent)	58.0 to 67.0	32.3 to 53.5	48.0 to 55.0
Silica (per cent)	20.3 to 24.1	21.1 to 35.1	18.0 to 28.0
Alumina (per cent)	5.2 to 10.6	6.3 to 14.5	9.0 to 19.0
Iron oxide (per cent)	2.1 to 5.3	1.7 to 5.1	0.3 to 2.8
Magnesia (per cent)	0.3 to 2.3	1.4 to 20.9	0.5 to 7.0
Sulphuric acid (per cent)	0.3 to 1.8	....	0.2 to 2.7

The process of formation and hardening of the cement is similar in all cases, depending chiefly upon the formation of calcium silicates, which become hydrated and crystallize under the action of water. If it were possible to find a natural product containing lime and clay in the right proportions, a cement of the correct Portland standard could be made from it by the simple operations of calcining and grinding; but a variation of 1 per cent from the correct standard greatly reduces the value of the cement. Most of the argillaceous limestones of the United States contain a high proportion of magnesia and an excess of clay. If burned at the high temperature necessary to produce Portland cement, they fuse to a slag which does not possess hydraulic properties; but when burned at a heat only sufficient to drive off the carbonic acid, they yield a soft yellow clinker, which, when ground, gives the natural-rock cement of commerce.

PORTLAND CEMENT.

Ingredients used.—The necessary materials for Portland cement are calcium carbonate (usually in the form of limestone, chalk, or marl) and clay or shale. The relative proportions of the two depend upon their varying composition.

The calcium carbonate should be as pure as possible, except for the presence of clay. Magnesia is always present to some extent, and though it is generally agreed that up to 3.5 per cent it is harmless, a large percentage is objectionable. Calcium sulphate in excess of about 2.5 per cent is also objectionable, unless a decided oxidizing flame be maintained in burning, as it is liable to be reduced to the sulphide. Both magnesia and calcium sulphate are considered especially objectionable in cements that are to be exposed to the action of sea water.

In England a comparatively soft chalk is generally used; in Germany, chalk or limestone. In the United States a large part of the Portland cement is made from the slate-like limestone of the Lehigh valley region. This material contains rather more clay than is required for a correct mixture, so that a small proportion of pure limestone—usually from 10 to 20 per cent—is added. In New York, Ohio, and Michigan marl, a soft fresh-water deposit similar to chalk, is generally employed. Pure limestone is used in a few cases only.

The chemical composition of certain typical forms of calcium carbonate used in the manufacture of Portland cement is shown in the following table:

CONSTITUENTS.	CHALK.	CEMENT ROCK.			MARL.	
	England (Kent).	Lasalle, Ill.	Phillipsburg, N. J.	Siegfried, Pa.	Sandusky, Ohio.	Syracuse, Ind.
Calcium carbonate	98.57	88.16	70.10	68.91	91.77	88.49
Silica	0.64	8.20	15.05	17.32	0.22	1.78
Alumina	0.16	1.00	9.02	7.07	1.22	0.91
Iron oxide	0.08	0.30	1.27	2.04	0.40	0.30
Magnesium carbonate	0.38	1.78	3.96	4.28	0.53	2.71
Calcium sulphate	......	......	......	......	3.19	1.58

The clay should be highly siliceous, low in magnesia and sulphates, and free from sand. For the best results the proportion of silica should be at least three times as great as that of iron oxide and alumina combined. Highly aluminous clays give a fusible clinker and quick-setting cement, while clays containing more than 5 per cent of iron oxide give a dark-colored cement.

The following table presents an analysis of a few typical clays used in Portland cement manufacture:

CONSTITUENTS.	Medway, England.	Harper, Ohio.	Sandusky, Ohio.	Lasalle, Ill.
Silica	70.56	51.50	65.43	54.30
Alumina	14.52	13.23	16.51	19.33
Iron oxide	3.06	3.30	6.06	5.57
Lime	4.43	11.52	2.22	3.29
Magnesia	......	3.45	1.88	2.57
Carbonic acid	3.48	12.85	......	......
Alkalies	3.35	......	......	......

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[1] "Portland Cement," by S. B. Newberry, in "The Cement Industry," reprinted from the Engineering Record, has been largely drawn from.

The small proportion of alkalies present in ordinary clays exerts but little influence and hence is not generally determined.

Mixing.—The method of mixing originally practiced in England was the wet process, in which the materials were ground and mixed in water, and settled in reservoirs, and the "slurry" dried previous to burning. In the dry process, now largely used, the materials are ground and mixed in the dry state. Marl and clay are mixed in a plastic condition. Rock crushers, followed by buhrstones, emery mills, tube mills, or Griffin mills, are generally used for the dry grinding of raw material, and pans with edge runners, followed by tube mills, for wet grinding. The chemical composition of the mixture is constantly tested, and the percentage of calcium carbonate is kept within the 0.5 per cent of that found to be correct for the materials used.

Burning.—Over 95 per cent of the Portland cement is now burned in rotary kilns. The rotary kiln consists of a slightly inclined cylinder, lined with fire brick, turning at the rate of one revolution in from one to three minutes. Fuel oil was formerly used as a source of heat, but powdered coal is now generally employed. The cement material is fed in continuously at the upper end in the form of dry powder, or, in the case of marl and clay, as liquid mud. Descending gradually, it parts with its water, if any, in the upper third of the kiln, becomes heated to redness, loses its carbonic acid, forms small rounded balls which reach a nearly white heat in the lower third of the kiln, and finally issues at the lower end as well-burned black clinker in grains about pea size.

When the burning is done in vertical kilns, the dry powder is first moistened and molded into bricks, which are again dried before being fed into the kiln. According to Le Chatelier, the following changes take place during the burning: At a red heat the combined water is expelled from the clay; at a somewhat higher temperature the calcium carbonate is decomposed into carbonic acid gas, which escapes, and lime, which immediately enters into combination with the silica and alumina of the clay, producing calcium silicates and aluminates. At first, fusible glasses, rich in silica, are formed; by combining with more lime, these gradually become more and more basic, until at last the tricalcium silicate is produced. The iron and alumina also remain in combination with lime as an alumino-ferrite.

The proper degree of burning is indicated by the formation of a dense green-black clinker. Underburned clinker is brownish and soft, while overburned clinker is fused and slag-like; long-continued burning or an excess of clay causes the clinker to "dust" or fall to powder on cooling, the resulting powder showing little or no hydraulic properties. Underburned cement is apt to be quick-setting and to expand and crack in hardening; on the other hand, overburned cement is usually slow in setting and hardening, though it may show excellent tests at long periods. Cement properly proportioned, mixed, and burned does not begin to set in less than two hours after mixing with water, but after the setting begins it hardens rapidly and shows a steady gain in strength, especially when tested with sand, up to several years. It is an almost universal practice to add from 1 to 2 per cent of ground gypsum to retard the setting.

Grinding.—Portland cement clinker was formerly ground with buhrstones and bolted through revolving screens. At present the Griffin mill or the German ball mill, followed by the tube mill, is generally used. A degree of fineness, such that 92 to 93 per cent will pass through a No. 100 sieve, is generally attained. Finer grinding can easily be accomplished, if necessary, but is rarely demanded. There is, of course, a point beyond which it is not economical to carry the fine pulverizing of cement, since the same result can be accomplished by using slightly richer mixtures.

The numerous tests shown in the reports of Government and private engineers warrant the claim that no Portland cement made in any foreign country equals the product of the leading American factories.

NATURAL ROCK CEMENT.

Of the natural rock cement produced in the United States in 1902, about 45 per cent came from the state of New York; about 22 per cent from Kentucky and Indiana, within a radius of 15 miles of Louisville, Ky.; and the remainder largely from Pennsylvania and Illinois.

Rosendale cements. Of the natural-rock cements the Rosendale cements, manufactured in Ulster county, N. Y., from a natural cement rock known as the Tentaculite or water-lime deposit of the lower Helderberg group of the New York Geological Survey, are typical.

The Rosendale cement industry is the oldest manufacture of hydraulic cement in the country. Dating from 1832, the industry has been developed conservatively and successfully.

The rock deposit is a magnesian limestone, of which two different beds, known respectively as the "light" rock and the "dark" rock, are quarried for cement. Both rocks are hard, compact, and close-grained, the light rock having a steely-blue color, and the dark a duller and deader color and a more shaly appearance. Apparently the light rock contains the more lime and the dark the more clay. After calcination the light rock is yellow, and the dark a redder or dark sienna color. It is a tradition that no good cement can be made without a mixture of the two.

At Binnewater, Ulster county, the depth of the dark-rock deposit, which is the lower bed of cement rock, is about 18 feet, that of the light rock is from 10 to 17 feet, and that of the unworked strata between the two is about 12 feet. The dip varies, but is generally about 45 degrees. The general mining scheme is to run slopes to a depth of about 40 feet, following the dip of the dark rock, and then to start breasts or headings in both directions along the strike. When the headings have been run out to daylight, to property limits, or to the limit of economical working, the slope is run down 40 or 50 feet farther and new headings started. The rock is loaded on cars which are run through the headings to the foot of the slope and hauled up by cable. To get at the light-rock deposit, which is overhead, horizontal gangways are cut from the gangways in the dark rock through the hanging wall into the bed of light rock, and headings are then started in it in both directions, just as in the lower formation, the cars being run through the connecting gangways and up the slope.

In chemical composition the Rosendale cements are remarkable for the high proportion of magnesia they contain; it varies considerably in different Rosendale brands, but the following analysis is typical of these cements as a class:[1]

Silica	24.30
Alumina	7.22
Ferric oxide	5.06
Lime	33.70
Magnesia	20.94
Volatile matter and undetermined	8.78
Total	100.00

The condition of the successful use of magnesian limestones is light burning, and this requirement is carefully observed in all the Rosendale factories.

Louisville cements.—The so-called Louisville cements are next in importance to the Rosendale product. An extensive deposit of limestone occurs at Louisville, Ky., forming the bed of the Ohio river, and causing the falls and rapids at that place. The first manufacture of Louisville cement began alongside of and in conjunction with the construction of the Louisville and Portland Canal around the Louisville falls. The largest plant in the Louisville district is at Speeds, Indiana.

The cement rock is of the same geological horizon as the water-lime deposits of New York, Pennsylvania, and Wisconsin. A general analysis is about as follows:

Silica and insoluble matter	15.0
Alumina and iron oxide	6.0
Calcium carbonate	61.0
Calcium sulphate	5.0
Magnesium carbonate	10.0
Water, alkalies, etc	3.0
Total	100.0

It is worked both in open quarries and by mining. At the Speeds mills the rock is graded into three sizes, at a breaker provided with screens, the fine stuff calcining more readily than heavy rock.

Manufacturing process.—For calcining natural cement rock, vertical kilns are generally used. They are operated continuously, by drawing from the bottom and charging at the top. In charging, a layer of rock is thrown in, then a thin layer of anthracite pea coal, then another layer of rock, etc. The fuel consumption is low, the output of cement per ton of coal being quite high. At Binnewater the kilns are 28 feet high and 10 feet in diameter, with a daily capacity of from 90 to 100 barrels of marketable cement stone, after discarding all hard burned clinker and sorting out the underburned clinker for recalcination. At the Speeds mills they are 30 feet high and have an inside diameter of 13 feet, with a daily capacity up to 250 barrels.

The calcined rock is run through crackers and then screened; the coarse rock is next ground in mills, but the finest grades pass directly to the barrel packers. The product is packed as it is ground, nearly all of it in barrels.

SLAG CEMENT.

The manufacture of hydraulic cement from furnace slag has reached considerable proportions abroad, but in this country it is comparatively a new industry. It is not directly within the scope of the mining census, but it is noticed briefly because it utilizes a waste product of mined material.

It is only occasionally that ores and fluxes employed in blast furnaces will produce slag suitable for cement, furnace slags as ordinarily produced by casting and slow cooling being devoid of hydraulic properties. Slag to be used for cement is run off from the furnaces and dropped in a molten state into a trough through which is forced a large stream of cold water; the slag solidifies in vesicles or bubbles, which break up into thin, shell-like pieces. The best grade of such slag has a delicate blue color, and though hard is thin and porous, and hence is readily crushed. The rest of the process is extremely simple, consisting in drying the slag, mixing it with the proper proportions of slaked lime, and then grinding the mixture to a fine powder. The Maryland Cement Company utilizes the slag from the blast furnaces of the Maryland Steel Company, at Sparrow Point, Md. Cuban iron ores are largely used in these furnaces with oyster shells as flux.

INVENTIONS.

Invention has played an important part in the development of the cement industry, both in the improvement of cement compositions and processes of manufacture and in the perfecting of methods and machinery, whereby the cost of manufacture has been greatly reduced and uniformity of product secured. Many of the operators own and control patents for such inventions; a digest of all patents pertaining to processes or compositions employed in the industry—not including patents for apparatus or machines—is attached hereto. The term of a United States patent is seventeen years, so that all patents which have run for that period are public property.

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[1] The Cement Industry, page 153.

TABLE 8.—DETAILED SUMMARY: 1902.

	United States.	Illinois.	Indiana.	Maryland.	Michigan.	New York.	Ohio.	Pennsylvania.	Virginia.	All other states.[1]
Number of mines or quarries	101	6	9	4	11	21	7	17	8	23
Number of operators	93	6	7	4	10	20	7	14	7	22
Character of ownership:										
Individual	4					3				1
Firm	6			1		4				1
Incorporated company	83	6	7	3	10	13	7	14	5	20
Salaried officials, clerks, etc.:										
Total number	932	[illegible]	[illegible]	12	102	141	49	207	48	231
Total salaries	$1,087,534	[illegible]	[illegible]	17,227	$131,131	$160,282	$57,898	$250,252	$44,675	$205,681
General officers—										
Number	148	12	9	5	17	21	14	26	6	37
Salaries	$347,132	[illegible]	[illegible]	[illegible]	$43,450	$46,801	$21,600	$75,285	$15,900	$91,250
Superintendents, managers, foremen, surveyors, etc.—										
Number	405	[illegible]	21	6	58	50	19	91	20	110
Salaries	$476,461	$20,868	[illegible]	[illegible]	$68,281	$66,731	$25,703	$108,756	$18,900	$152,966
Foremen, below ground—										
Number	20		1	4		11	1		1	2
Salaries	$15,010		[illegible]	[illegible]		$9,025	$700		$375	$1,490
Clerks—										
Number	[illegible]	10	[illegible]	7	27	56	15	90	16	85
Salaries	$248,711	[illegible]	[illegible]	[illegible]	$19,400	$37,725	$9,897	$68,211	$9,900	$60,878
Wage-earners:										
Aggregate average number	13,041	[illegible]	[illegible]	[illegible]	938	2,459	375	5,376	178	2,489
Aggregate wages	$6,328,852	[illegible]	[illegible]	[illegible]	$685,570	$1,203,243	$227,548	$2,411,652	$84,423	$1,263,794
Above ground—										
Total average number	12,524	484	[illegible]	107	938	2,083	366	5,376	163	2,476
Total wages	$6,081,053	$258,656	[illegible]	$45,232	$685,570	$1,022,946	$219,962	$2,411,652	$79,423	$1,257,429
Engineers, firemen, and other mechanics—										
Average number	2,092	[illegible]	77	15	147	82	[illegible]	1,146	39	321
Wages	$1,324,121	$33,879	[illegible]	$8,760	$114,955	$103,471	$32,277	[illegible]	$29,695	$238,690
Miners or quarrymen—										
Average number	2,766	75	125	6	171	184	52	1,403	56	394
Wages	$1,210,26[illegible]	$30,047	$53,257	$2,137	$87,802	$89,472	$29,256	[illegible]	$21,001	$281,450
Boys under 16 years—										
Average number	100		1	1		52		15	6	24
Wages	$22,450		$231	$200		$8,169		$9,162	$1,297	$3,440
All other wage-earners—										
Average number	7,557	393	328	85	630	1,466	275	2,662	62	1,637
Wages	$3,527,111	$184,150	$154,168	$34,235	$532,813	$761,834	$159,426	$1,138,619	[illegible]	$732,999
Below ground—										
Total average number	517	1	37	63		376	9		15	13
Total wages	$241,799	$5,250	$13,798	$29,445		$180,297	$7,780		$4,000	$6,965
Miners—										
Average number	265	1	37	58		130	8		15	13
Wages	$130,658	$5,250	$13,798	$29,445		$69,738	$7,080		$4,000	$6,965
Miners' helpers—										
Average number	220					220				
Wages	$90,100					$90,100				
Boys under 16 years—										
Average number	2					2				
Wages	$869					$869				
All other wage-earners[2]—										
Average number	30			5		24	1			
Wages	$14,072			$2,000		$10,372	$700			
Average number of wage-earners at specified daily rates of pay:										
Engineers—										
$1.00 to $1.24	2							2		
$1.25 to $1.49	29					2		25	1	1
$1.50 to $1.74	31					1	1	29		
$1.75 to $1.99	23		1	1		6		11	1	3
$2.00 to $2.24	98	5	11	1	5	15	6	28	2	24
$2.25 to $2.49	58		2	2	6	3		21	1	23
$2.50 to $2.74	42	3	1		6	11	4	8		7
$2.75 to $2.99	15				5	2		2		6
$3.00 to $3.24	26	1			9	2	1	6		7
$3.25 to $3.49	3								2	1
$3.75 to $3.99	3	1			1				1	
$4.00 to $4.24	1	1								
Firemen—										
$0.75 to $0.99	2									2
$1.00 to $1.24	31							28		3
$1.25 to $1.49	27		2	1		2	2	18	1	1
$1.50 to $1.74	67		12	2	5	20		5	9	13
$1.75 to $1.99	89	1			6	17	8	47		10
$2.00 to $2.24	87	11	3	1	2	18	5	29		19
$2.25 to $2.49	24				9	4				11
$2.50 to $2.74	5							1		4
$2.75 to $2.99	1				1					
$3.00 to $3.24	8	1			5					2
Machinists, blacksmiths, carpenters, and other mechanics—										
$0.75 to $0.99	2									1
$1.00 to $1.24	70							66		4
$1.25 to $1.49	130		5	1		4		116		4
$1.50 to $1.74	251	1	10			21		192	8	19
$1.75 to $1.99	214	1	3	1	15	18	2	158		16
$2.00 to $2.24	300		4	1	8	29	2	231	1	17
$2.25 to $2.49	119	9	3	1	18	40		38	4	6
$2.50 to $2.74	190	4	13	1	18	29	6	36		83
$2.75 to $2.99	49	3			12	7		18	2	7
$3.00 to $3.24	58	3	1		11	2	3	26	1	11
$3.25 to $3.49	32	1			1	3		20		7
$3.50 to $3.74	5					2				3
$3.75 to $3.99	2				1					1
$4.00 to $4.24	2					1				1
$4.25 and over	1								1	
Miners or quarrymen—										
$0.50 to $0.74	2		2							
$0.75 to $0.99	54								25	29
$1.00 to $1.24	350		20	6				301	2	21
$1.25 to $1.49	1,206		81	31	1	73	7	763	54	196
$1.50 to $1.74	894	27	42	7	90	121	10	410		187
$1.75 to $1.99	327	45	2	20	63	50	7	19		121
$2.00 to $2.24	169	3	1		11	75	25	2		67
$2.25 to $2.49	26		1			11	2	1		5

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[1] Includes operators distributed as follows: Alabama, 1; California, 2; Colorado, 1; Georgia, 2; Kansas, 2; Kentucky, 1 (2 quarries); Minnesota, 2; Missouri, 1; New Jersey, 2; North Dakota, 1; South Dakota, 2; Texas, 2; Utah, 1; West Virginia, 1; Wisconsin, 2.

[2] Includes timbermen and track layers.

TABLE 8.—DETAILED SUMMARY: 1902—Continued.

	United States.	Illinois.	Indiana.	Maryland.	Michigan.	New York.	Ohio.	Pennsylvania.	Virginia.	All other states.
Average number of wage-earners at specified daily rates of pay—Continued.										
Miners or quarrymen—Continued.										
$2.50 to $2.74	32	1	1			1		9		20
$2.75 to $2.99	8						8			
$3.00 to $3.24	2				1			1		
Miners' helpers—										
$1.50 to $1.74	220					220				
Timbermen and track layers—										
$1.25 to $1.49	14					7		7		
$1.50 to $1.74	1									1
$1.75 to $1.99	2					1				1
Boys under 16 years—										
Less than $0.50	37							24		13
$0.50 to $0.74	15		1	2		4		1	5	2
$0.75 to $0.99	38					14		23		1
$1.00 to $1.24	19					14				5
$1.25 to $1.49	1					1				
$1.50 to $1.74	1					1				
All other wage-earners—										
$0.50 to $0.74	3		2							1
$0.75 to $0.99	97						3	25		69
$1.00 to $1.24	620		4	12	2	12	3	566	5	16
$1.25 to $1.49	2,482		96	78	23	418	36	1,325	6	500
$1.50 to $1.74	2,655	307	200	8	210	888	59	361	30	593
$1.75 to $1.99	974	13	7	10	338	163	24	135	1	283
$2.00 to $2.24	279	23	6		37	38	77	55		43
$2.25 to $2.49	200	17			1	26	72	63		21
$2.50 to $2.74	164		7	2	5	32	2	113		3
$2.75 to $2.99	30	2			3	14		10		2
$3.00 to $3.24	31	1			5	14		11		
$3.25 to $3.49	12				3	1		7		1
$3.50 to $3.74	11					10		1		
$3.75 to $3.99	2					2				
$4.00 to $4.24	1				1					
$4.25 and over	3				2	1				
Average number of wage-earners employed during each month:										
Men 16 years and over—										
January	10,330	418	327	138	420	1,888	335	4,670	145	1,989
February	10,272	420	294	133	419	1,846	353	4,683	157	1,957
March	10,771	434	413	129	564	1,729	355	4,834	161	2,152
April	12,290	445	447	175	701	2,420	386	5,050	171	2,495
May	13,180	463	475	179	1,051	2,749	386	5,154	176	2,547
June	13,280	492	452	186	1,077	2,775	390	5,171	169	2,568
July	13,479	480	451	187	1,109	2,738	360	5,241	179	2,734
August	14,506	484	665	191	1,179	2,688	361	5,907	189	2,842
September	14,549	485	757	177	1,171	2,725	393	5,933	183	2,725
October	14,349	477	865	190	1,191	2,555	382	5,859	188	2,642
November	14,185	631	849	179	1,191	2,509	417	5,721	184	2,504
December	13,969	627	848	176	1,183	2,478	422	5,636	192	2,407
Boys under 16 years—										
January	96			1		30		37	6	22
February	92					30		34	6	22
March	112		1	1		33		46	6	25
April	123		1	2		35		54	6	25
May	123		2	1		35		54	6	25
June	116		1	1		35		48	6	25
July	115		1	1		35		49	6	23
August	116			1		35		49	6	25
September	117		2	1		35		48	6	25
October	110		2	1		35		41	6	25
November	110		2	1		35		43	6	23
December	102			1		35		37	6	23
Contract work:										
Amount paid	$10,627					$4,450				$6,177
Number of employees	34					4				30
Miscellaneous expenses:										
Total	$1,665,520	$35,621	$53,447	$17,914	$170,477	$310,772	$71,829	$711,782	$31,487	$262,191
Royalties and rent of mine and mining plant	$52,905			$2,201		$11,644	$1,677	$13,448		$23,935
Rent of offices, taxes, insurance, interest, and other sundries	$1,612,615	$35,621	$53,447	$15,713	$170,477	$299,128	$70,152	$698,334	$31,487	$238,256
Cost of supplies and materials	$9,068,225	$185,881	$420,168	$51,879	$704,287	$1,474,640	$231,422	$4,048,508	$91,100	$1,860,191
Product:										
Quantity, barrels	24,655,363	1,058,081	1,879,891	409,200	1,577,000	4,734,147	597,088	9,960,802	284,000	4,786,142
Value	$24,298,558	$702,251	$1,290,228	$150,680	$2,134,396	$3,656,589	$714,551	$10,223,267	$327,650	$5,666,717
Portland cement—										
Quantity, barrels	16,691,055	450,261	536,703		1,577,000	1,156,807	559,613	8,163,926	250,000	3,627,733
Value	$20,221,708	$545,396	$632,244		$2,134,396	$1,521,553	$681,196	$9,882,598	$307,650	$4,165,046
Natural-rock cement—										
Quantity, barrels	7,964,308	607,820	1,343,188	409,200		3,577,340	37,475	796,876	34,000	1,158,409
Value	$4,076,850	$156,855	$657,984	$150,680		$2,135,036	$33,355	$340,669	$20,000	$542,651
Kilns:										
Total number	1,035	23	99	42	86	283	29	299	13	161
Vertical	584	11	71	42		234	5	146	5	70
Rotary	451	12	28		86	49	24	153	8	91
Power:										
Total horsepower	114,062	6,925	7,980	1,520	11,865	20,466	5,150	35,498	2,610	22,378
Owned—										
Engines—										
Steam—										
Number	505	30	37	9	49	80	24	163	12	101
Horsepower	103,811	6,525	6,230	1,520	10,465	18,815	5,150	35,448	2,610	17,248
Gas or gasoline—										
Number	15									15
Horsepower	2,880									2,880
Water wheels—										
Number	21				12	7		1		1
Horsepower	1,854				1,400	354		50		50
Other power—										
Number	9	3	5							1
Horsepower	2,195	400	1,750							45
Rented—										
Electric, horsepower	3,442					1,297				2,145
Electric motors owned—										
Number	474	38	36		99	92	23	257	15	45
Horsepower	17,120	882	1,426		5,177	2,895	900	4,590	825	1,295
Supplied to other establishments, horsepower	20				20					

APPENDIX.

DIGEST OF UNITED STATES PATENTS RELATING TO CEMENT.[1]

371—October 6, 1837. E. C. Warner. *Mode of manufacturing hydraulic cement from basanite.*

Basanite Lydian stone, sometimes called "touchstone," is calcined to a red heat and ground.

119413—September 26, 1871. D. C. Saylor. *Improvement in the manufacture of cement.*

A hydraulic cement is produced from argillo-magnesian and argillo-calcareous limestone.

126989—May 21, 1872. D. C. Saylor. *Improvement in the manufacture of hydraulic cement.*

Argillo-magnesian limestone is burned and crushed, one-fifth of its weight of raw stone is added thereto, and the mass is then ground.

154641—September 1, 1874. F. E. and W. L. Brown. *Improvement in hydraulic cement.*

Coralline, coral rock, or fossil coral is used for the manufacture of hydraulic cement.

167653—September 14, 1875. C. F. Dunderdale. *Improvement in hydraulic cement.*

Kaolin, or other silicate of aluminum, fuller's earth, and lime are mixed, burned, and ground.

174387—March 7, 1876. A. Smith. *Method of manufacturing lime and cement.*

Lime, or cement rock, is burned with oil, delivered into the combustion chamber in a fluid state, in spray, or as vapor, along with steam, superheated or not, and air.

176938—May 2, 1876. C. F. Dunderdale. *Improvement in the manufacture of artificial hydraulic cement.*

The cement materials are crushed and mixed in water in a dense, semifluid state, flowed direct onto a drying floor or pan, then pressed and burned.

195749—October 2, 1877. C. F. Dunderdale. *Improvement in compositions for making hydraulic cement.*

It consists of infusorial silica and a silicate of aluminum with lime, burned and ground.

204532—June 18, 1878. W. J. Budington. *Improvement in the manufacture of hydraulic cement.*

A cement made of fossiliferous limestone and blue clay.

205253—June 25, 1878. J. Dimelow. *Improvement in the manufacture of hydraulic cement.*

A hydraulic cement formed of rotten, decomposed, or refuse limestone or marble, and the deposit of rivers, in about equal proportions.

205616—July 2, 1878. U. Cummings and L. J. Bennett. *Improvement in the manufacture of hydraulic cement.*

The method consists in first crushing and disintegrating the calcined and the vitrified portions of the cement stone, then separating the vitrified portion by screening or bolting and reducing the vitrified portion separately to powder.

212094—February 11, 1879. J. A. Francis. *Improvement in the manufacture of hydraulic cement.*

It consists in the use of blue clay combined with coal ashes and sewer mud.

213459—March 18, 1879. C. H. Slicer. *Manufacture of Portland cement.*

The cement making material consists of ground oyster shells, raw or burned, mixed with siliceous clay.

217415—July 8, 1879. J. K. Shinn. *Manufacture of lime and cement.*

To rapidly produce lime and cement, the raw material is subjected, while burning, to the action of a forced blast, continued until burning is complete, and the forced blast is then sustained to effect rapid cooling.

222004—November 25, 1879. C. Brown. *Improvement in the manufacture of artificial hydraulic or Portland cement.*

The mixed raw material is molded into hollow cylindrical forms or perforated sphere balls.

223815—January 27, 1880. F. Ransome. *Manufacture of cement and artificial stone.*

A white or artificially tinted cement is made from a mixture of kaolin or china clay and chalk or marble, by burning in muffle-kilns or retorts without contact with fuel.

230865—August 10, 1880. A. T. Easterby. *Hydraulic cement.*

Travertine is employed for the manufacture of hydraulic cement.

231172—August 17, 1880. H. Jordan. *Cement compound.*

A cement compound, to be calcined, composed of silica, oxide of iron, and alumina, combined with the refuse from soda works, composed of lime, soda, potash, magnesia, and alum, tempered with refuse from gas works or tanneries.

231858—August 31, 1880. E. Solvay. *Process for the manufacture of cement.*

The residue from the decomposition of calcium chloride by a silicate of aluminum, such as clay, is used as the basis for the manufacture of cement.

237500—February 8, 1881. J. Dimelow and R. M. Peadro. *Manufacture of hydraulic cement and lime.*

Rotten or decomposed limestone is burned and then subjected to currents of air or steam in a tightly closed receptacle, and the material then sifted, with or without grinding.

245574—August 9, 1881. J. B. Speed. *Treatment of hydraulic cement in the kiln.*

Steam is admitted to the mass after it has fallen below the point where it is burned.

245699—August 16, 1881. W. J. Budington. *Manufacture of hydraulic cement.*

It is made of white marble of the second formation and blue clay.

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[1] Printed copies of patents are sold by the Commissioner of Patents at 5 cents each.

249548—November 15, 1881. J. Reese. *Preparing, indurating, and solidifying calcareous lining materials for furnaces.*

Lime is mixed with carbon or a hydrocarbon, then subjected to a high temperature in a cupola until fusion takes place, and, finally, run into suitable shapes for linings.

256103—April 4, 1882. V. Einaigl. *Manufacture of artificial stone.*

A mixture of carbonate of sodium, carbonate of potassium, calcined quartz sand, oxide of calcium, oxide of magnesium, clay, and siliceous sand forms an artificial stone. A hydraulic cement is produced without calcination by adding to 120 parts of said mixture 300 parts of carbonate of lime, 200 parts of oxide of calcium, of which 150 parts are previously slaked, and 380 parts of brick-dust.

260546—July 4, 1882. E. J. De Smedt. *Manufacture of hydraulic lime and hydraulic cement.*

The lime of cement stone is treated, at the time of calcination or afterwards, to a red heat while in contact with carbonic acid.

263810—August 29, 1882. W. F. Browne. *Process of and means for manufacturing a heating fuel for burning lime, etc.*

The products of combustion are exhausted from a lime kiln, and forced by a jet of gaseous vapor under pressure into a carbureting chamber, where the mixture is enriched with oil vapor; it is then forced under pressure into the kiln, whereby the hot products of combustion and gases are circulated through the latter, thus insuring uniform burning.

263873—September 5, 1882. E. J. De Smedt. *Manufacture of hydraulic cement.*

Slow-setting hydraulic cement is produced from cement stone containing an excess of free anhydrous lime, by adding to the calcined stone, before or after grinding, sufficient water to combine with the free anhydrous lime, forming calcium hydrate.

270097—January 2, 1883. J. Murphy. *Hydraulic cement.*

It is composed of iron slag, soapstone, and burned or roasted clay and lime, in the proportions of 2 parts of slag to 1 part of each of the other ingredients.

270608—January 16, 1883. L. Roth. *Manufacture of cement.*

A cement is formed by calcining and grinding a mixture of bauxite, or minerals similar to bauxite, with quartz, hydrated silicic acid, infusorial earth, blast-furnace slag or other silicates, and lime, either as limestone, chalk, or burnt lime, with or without admixture of dolomite, oxide of iron, raw soda, alkali ash, or other fluxes.

274288—March 20, 1883. E. J. De Smedt. *Art of manufacturing Portland cement.*

A hydrocarbon or other combustible is added to and mixed with the cement material prior to calcining.

274734—March 27, 1883. E. J. De Smedt. *Manufacture of Portland cement.*

Enough lime is combined with cement rock or hydraulic limestone, either before or after calcining, to bring the percentage of lime up to about 70 per cent.

274735—March 27, 1883. E. J. De Smedt. *Manufacture of Portland cement.*

Enough dolomite is combined with cement rocks or hydraulic limestone, either before or after calcining, to bring the percentage of lime and magnesia up to about 70 per cent.

275369—April 10, 1883. E. J. De Smedt. *Hydraulic cement compound.*

A cold, slow-setting hydraulic cement, composed of not more than 50 per cent in bulk of a slaty or siliceous non-cement producing rock in combination with not less than 50 per cent of the hot, quick-setting cement rock in common use for cement manufacture.

279354—June 12, 1883. E. J. De Smedt. *Art of manufacturing Portland cement.*

Natural rock is calcined, ground, formed into a cement paste, and then recalcined and reground.

281965—July 24, 1883. W. J. Budington. *Cement compound.*

It is composed of the variegated marble of the second formation (dark and white), and blue clay.

287941—November 6, 1883. W. Jones. *Hydraulic Portland cement.*

Hydraulic Portland cement is made from argillaceous limestone or dolomite containing an excess of clay, by mixing therewith lime or its carbonate in such quantity that the mixture shall contain 70 to 80 per cent of carbonate of lime, then molding, calcining, and grinding.

292329—January 22, 1884. R. W. Lesley and J. M. Willcox. *Manufacture of Portland cement.*

The pulverized cement material is dampened slightly so that it is still a powder and not a paste, molded into balls or lumps by hard pressure, and then calcined and ground.

294080—February 26, 1884. L. Roth. *Manufacture of cement.*

A mixture of blast-furnace cinder, say 100 pounds; carbonate of lime, 135 pounds; and an alkaline chloride, such as carnallite, 15 to 20 pounds in a saturated solution, is calcined and ground.

300790—June 24, 1884. J. Murphy. *Hydraulic cement.*

It is composed of fibrolite, margarite, iron slag, shell marl, and clay, mixed, burned, and ground.

305201—September 16, 1884. R. W. Lesley. *Manufacture of Portland cement.*

Lime, or lime and magnesia in any of their forms, and slate are mixed in substantially such proportions as to make the manufactured cement analyze about 70 per cent of lime, or lime and magnesia, to 30 per cent of alumina and silica, then calcined and ground.

305753—September 30, 1884. R. W. Lesley. *Manufacture of hydraulic cement.*

A slow-setting hydraulic cement is made by mixing ferruginous earths or stones, such as are used in the manufacture of the mineral brown and red paints of commerce, with quick-setting cement rocks in suitable proportions, and then calcining and grinding.

305754—September 30, 1884. R. W. Lesley and D. Griffiths. *Manufacture of Portland cement.*

Iron slag or cinder, as an essential ingredient, is mixed with lime, or lime and magnesia in any of their forms, and calcined and ground, the proportions being such as to bring the percentage of lime, or lime and magnesia, up to about 70 per cent.

305670—September 30, 1884. S. H. Short. *Manufacture of hydraulic cement.*

A mixture of limestone containing from 5 to 15 per cent of clay and from 3 to 10 per cent of magnesia, mixed with a clay containing about 60 per cent of carbonate of lime, 30 per cent of silica, and 10 per cent of magnesia and alkaline carbonates, is formed into bricks, burned, and ground.

309150—December 9, 1884. E. F. Loiseau. *Art of manufacturing Portland cement.*

The cement powder is kept in a granular condition before it goes upon the rolls, by the addition of "binders" of larger size than the cement powder, and composed preferably of coke dust, coal, culm, raw cement, or limestone.

309270—December 16, 1884. S. T. Wellman and G. W. Goetz. *Plant for and process of making lime.*

The process or mode of expelling or driving off carbonic acid gas by driving or drawing through the limestone air which has been more or less highly heated.

311895—February 10, 1885. D. Griffiths. *Manufacture of hydraulic cement.*

Raw rocks containing silica, preferably slates or argillo-calcareous limestones, and slaked lime, are incorporated with calcined cement rock or hydraulic limestone of the kind that produces hot, quick-setting cement.

313217—March 3, 1885. R. W. Lesley. *Manufacture of Portland cement.*

Black or dark-colored cement is produced by incorporating black chalk with the cement material after calcination.

315711—April 14, 1885. R. Bryce. *Manufacture of hydraulic cement.*

Leitchfield marl or shale, say 5 parts, and limestone 11 parts, are ground together, compressed into bricks, calcined, and ground.

321120—June 30, 1885. R. W. Lesley and D. Griffiths. *Art of manufacturing Portland cement.*

To destroy the clinker bridge formed in a kiln during the operation of calcining cement making material to a clinker, a current of cold air is directed against the underface of said bridge to effect the cooling, contraction, and breaking down of the same.

321121—June 30, 1885. R. W. Lesley and D. Griffiths. *Manufacture of cement.*

Cement is artificially seasoned after grinding by submitting it to the action of a forced current of air charged with moisture.

321589—July 7, 1885. J. Dimelow. *Manufacture of hydraulic cement.*

Decomposed limestone is employed for the manufacture of cement.

330602—November 17, 1885. H. Mathey. *Manufacture of cement.*

Cement rock is ground to a fine powder, which is then calcined.

331243—November 24, 1885. W. Joy. *Manufacture of cement.*

Wet slurry or a mixture of wet slurry and fuel is charged into a cement kiln, in successive portions, on the burning charge, at the parts where the charge is burning most freely.

333370—December 29, 1885. J. M. Willcox. *Manufacture of Portland cement.*

Powdered cement making material is mixed with a binding medium, which will be made soft and fluid by heat and which will harden when cooled—such as pitch—and molded and calcined, the binder finally volatilizing in the furnace.

339673—April 13, 1886. H. Mathey. *Manufacture of cement.*

Crushed rock is calcined in a revolving cylinder, and then pulverized.

340357—April 20, 1886. F. Ransome. *Manufacturing cement, etc.*

The cement material, reduced to a powder, is burned in a revolving furnace while exposed to the flame of producer gas mixed with a suitable amount of oxygen.

342784—June 1, 1886. U. Cummings. *Manufacture of cement.*

The cement making material consists of about 1,266 parts of gypsum by weight and of 400 parts of clay.

343182—June 8, 1886. H. Mathey. *Manufacture of hydraulic cement.*

The process consists in pulverizing natural cement rock, adding alluvial clay, mixing, and finally burning under agitation.

343183—June 8, 1886. H. Mathey. *Manufacture of hydraulic cement.*

Cement is colored by adding a metallic oxide to the burned cement rock before final pulverization.

343184—June 8, 1886. H. Mathey. *Manufacture of hydraulic cement.*

A pulverized metallic ore roasted to an oxide is added to the roasted cement of No. 343182 and the mixture ground.

343913—June 15, 1886. H. C. and D. Millen. *Process of manufacturing hydraulic cement.*

Fresh broken clay and marl are piled in alternate layers and allowed to remain until the clay absorbs the surplus moisture of the marl, when the mass is removed in vertical slices, reduced to a plastic condition, cut into blocks, dried, calcined, and ground.

346525—August 3, 1886. J. Anderson. *Making hydraulic cement.*

Crushed cement or limestone rock is immersed in a solution of acetic acid of moderate strength for about three hours, and then calcined, Roman cement being produced if calcined to a red heat and Portland cement if the calcining is carried to a white heat.

347367—August 17, 1886. J. Murphy and N. W. Lord. *Hydraulic cement.*

It consists of limestone, furnace slag, salt, and clay mixed, burned, and ground.

350415—October 5, 1886. U. Cummings. *Hydraulic cement.*

The process of hydrating hydraulic lime or cement consists in exposing the calcined and pulverized material, while in motion or agitation, to an atmosphere of steam.

358437—March 1, 1887. James and John D. Druecker. *Process of burning lime.*

The hot air is drawn from the top of the kiln and forced back to the fire by means of a blast.

373992—November 29, 1887. S. Lowden. *Manufacture of cement.*

First, a mixture of clay, 1 part, and chalk or limestone, 5 parts, is burned at a white heat and crushed; second, limestone is crushed separately and roasted at about 210° F.; and third, the products are mixed in the proportion of 3 parts of the first to 1 part of the second.

375590—December 27, 1887. R. Bosse, E. Friese, and F. Wolters. *Hydraulic and other cements.*

A cement composed of blast-furnace or other slag reduced to granular form, sand, and slaked lime, with or without silicic acid. Also process of making same.

382376—May 8, 1888. J. Murphy. *Hydraulic cement.*

Same as No. 347367, with the omission of the salt.

387199—July 31, 1888. G. L. Eagan. *Hydraulic cement compound.*

A combination of lime rock, silex, mineral magnesite, and alumina.

387588—August 7, 1888. C. R. Costling. *Process of manufacturing hydraulic cement.*

The cement material is crushed and ground, mixed with water to a plastic state and reground in this condition, next dried in a suitable chamber, and then calcined and again ground.

394663—December 18, 1888. J. T. Rigby. *Manufacture of cement from lime-mud.*

Lime-mud, the residue of alkali works, is washed and treated with carbonic acid, until sulphureted hydrogen ceases to be given off and then with sufficient alkaline silicate to decompose the alkaline-earth chlorides, when it is mixed with clay for the manufacture of cement.

397373—February 5, 1889. R. W. Lesley. *Manufacture of cement.*

In the manufacture of cement from slags, the lime or other ingredients, in a finely divided condition and at a high heat, are injected into the slag while still fluid.

399496—March 12, 1889. G. E. Carleton. *Method of calcining rock.*

An air blast is induced underneath the fuel to increase the draft, and a spray of steam or water within the arch above the fuel to regulate the heat.

402511—April 30, 1889. U. Cummings. *Cement.*

A hydraulic cement consisting of silicate of magnesium calcined and pulverized.

417634—December 17, 1889. G. Duryea. *Process of manufacturing cement.*

Fluorspar is mixed with cement-producing materials.

420371—January 28, 1890. J. M. Willcox. *Method of burning cement making materials.*

The cement making material in a kiln or chamber is subjected to the simultaneous action of the usual solid fuel, mixed with the material and forming part of the charge, and of auxiliary burning jets of gas or liquid fuel, applied to the upper strata of the charge before or about the time the lower strata are lighted.

427380—May 6, 1890. E. N. Trump and D. W. Peck. *Method of establishing units of measure in compounding Portland cement.*

Each ingredient is separately molded or cut into forms of uniform size, the sizes varying according to the proportions in which they are to be compounded.

433830—August 19, 1890. W. Joy. *Method of feeding cement kilns.*

Quantities of slurry and fuel mixed and quantities of neat slurry are separately deposited on the burning mass in the kiln at different times as the burning proceeds.

446911—February 24, 1891. H. C. BAUM. *Process of manufacturing Portland cement.*

Quicklime is added to wet calcareous marl, and through the resulting chemical action the mixture is rendered perfectly dry preparatory to grinding.

449510—March 31, 1891. G. WILLIAMS. *Process of manufacturing cement.*

Carbonate of lime is reduced to powder by steam, under pressure produced from a solution of silicate of soda and water; alumina, silex, and a thin paste of calcium chloride, unslaked lime, and warm water, are then added and the mixture is molded, calcined, and ground.

450750—April 21, 1891. J. B. SPEED. *Process of manufacturing hydraulic cement.*

The rock is crushed and sized by screening, and the furnace charged with lumps of a uniform size.

453753—June 9, 1891. E. F. BAUDE. *Manufacture of Portland cement.*

To obtain pure lime for the manufacture of Portland cement from blue limestone, the limestone is first calcined; the calcined lumps are next moistened by dipping in water and quickly removing them, so that only the pure lime will slake; and the pure, slaked lime is then separated from the impure by sifting.

455376—July 7, 1891. H. H. WING. *Manufacture of cement.*

A mixture composed of a phosphate, as calcium phosphate, and a silicate, such as clay or serpentine, the phosphate predominating (say 100 parts of phosphate rock to 46.29 parts of clay), is calcined.

460509—September 29, 1891. G. H. KOLTEYER and G. W. BARTHOLOMEW, Jr. *Process of preparing and tempering slurry for Portland cement.*

Freshly dug clay and lime materials are mixed in proportions determined by weight, worked while soft, damp, or wet, a portion of the mixed mass tested to determine proportions, and the proportions corrected, if necessary, by adding material.

460697—October 16, 1891. J. H. WRIGHT. *Hydraulic lime.*

Lime, slaked in a solution of crude potash, crude soda ash, and alum which has been boiled and cooled, is mixed with an equal quantity of lime slaked by dipping or sprinkling with sulphuric acid or with plaster of Paris, and the mixture is ground to a powder.

464515—December 8, 1891. J. F. NAVARRO. *Process of manufacturing hydraulic cement.*

The raw ground rock is burned in a vertical kiln and pulverized; the required additional element is then added, the pulverized mixture is calcined in a rotary kiln, and the product is ground.

464516—December 8, 1891. J. F. NAVARRO. *Process of manufacturing Portland cement.*

Argillaceous rock containing the constituents of Portland cement is ground in a dry state; when deficient in lime, a definite proportion of cement rock high in lime, or of pure limestone ground raw, is added; the powders are mixed dry and calcined in a rotary kiln, and the clinker is ground.

465530—December 15, 1891. C. TOMKINS. *Process of manufacturing cement.*

Highly heated slag as it comes from the furnace and before cooling is subjected to a bath of hydrate of lime, and then dried and pulverized.

486165—November 15, 1892. H. J. LIVINGSTON. *Composition of matter for producing Portland cement.*

It consists of 11 parts of shell containing 90 per cent and upward of carbonate of lime, 2 parts of alluvial clay, and 1 part of ground chalk flints.

486706—November 22, 1892. C. VAN FORELL. *Artificial Portland cement.*

Pulverized Roman cement is mixed with pure hydrate of calcium in the form of a dry powder so that the lime and the hydraulic factors are in the proportion of 17 to 10.

486707—November 22, 1892. C. VAN FORELL. *Artificial Roman cement.*

Pulverized Roman cement containing an excess of lime is mixed with powdered silicate of aluminum so that the lime and the hydraulic factors are in the proportion of 17 to 10.

491280—February 7, 1893. B. DREYFUSS. *Cement.*

A mixture of 2 parts of pulverized spent lime and 1 part of pulverized coke slag, with one-twentieth of its weight of slaked rock lime, and sand.

494763—April 4, 1893. V. F. L. SMITH. *Cement.*

A dry-ground mixture of ordinary cement with sand, gravel, or other filling material.

497785—May 23, 1893. M. L. GRIFFIN. *Manufacture of Portland cement.*

Precipitated carbonate of lime, produced by the addition of lime to a soluble carbonate, such as sodium carbonate, is mixed with clay or other aluminous material, dried, calcined, and ground.

506029—October 3, 1893. J. F. BARROW. *Production of lime.*

The products of combustion are exhausted from the bosh of the kiln, so that air may enter the furnace without mixing to an appreciable extent with the said products.

511638—January 2, 1894. S. DENTLER. *Manufacture of cement.*

It is composed of slaked lime, carbonate of potash, sulphate of copper, and sulphate of iron.

515017—February 20, 1894. E. L. RANSOME. *Slaking lime.*

The clinker produced in burning combustible material containing lime is slaked, disintegrated, and cooled by passing steam through the burned mass before it is withdrawn from the furnace.

515757—March 6, 1894. G. J. EVERETT. *Cement compound.*

It is composed of a cement which is itself hydraulic, chloride of calcium, and lime.

523647—July 24, 1894. B. K. RIGBY. *Manufacture of cement.*

"Ammonia-soda," or "Chance" waste is washed to remove soluble impurities, then tested chemically, and lime added until the impurities, other than soda and sodium chloride, are below 3.5 per cent, when it is mixed with aluminous material, calcined, and ground.

526910—October 2, 1894. B. K. RIGBY. *Manufacture of cement.*

A mixture of Le Blanc lime, mud, and clay is calcined until overburning takes place and then ground.

530247—December 4, 1894. G. W. A. STEIN. *Method of manufacturing hydraulic cement.*

From 5 to 10 per cent of slag, sand, and hydrate of lime is mixed with the raw cement materials to prevent disintegration before burning in a kiln.

543452—July 23, 1895. H. H. PIERCE. *Process of treating lime.*

Quicklime is slaked to a putty, then roasted and ground.

544766—August 20, 1895. J. WHITING. *Manufacture of cement.*

It is composed of pulverized blast-furnace or other slag, caustic soda, and slaked lime, all in the dry state.

545557—September 3, 1895. W. R. TAYLOR. *Apparatus for burning cement making materials and process of obtaining carbon dioxide.*

The materials are heated in direct contact with gaseous products of combustion until the moisture, organic matter, and the like are drawn off and the temperature reached at which carbonic acid is given off, when the heating is continued out of contact with the gaseous products of combustion.

550919—December 3, 1895. E. H. HURRY and H. J. SEAMAN. *Process of and apparatus for manufacture of cement.*

The cement material is roasted, the hot clinker partially cooled, broken, and wetted, and the moisture evaporated from the broken material in a continuous process.

562582—June 30, 1896. G. W. A. STEIN. *Hydraulic cement.*

A small quantity of ground slag sand or granulated furnace slag is added to a finished mixture of raw cement to make the sintered mixture brittle, so that on cooling the mass crumbles.

[illegible]—September 29, 1896. C. Bonneville. *Method of and apparatus for calcining cement.*

Raw cement material and cement proper are combined with a combustible material, in an intimately mixed and plastic mass, and are then subjected to a simultaneous rolling and calcining operation by which the mass is formed into separate lumps immediately before, and the combustible material burned out upon and immediately after the setting of the cement proper.

[illegible]—October 20, 1896. S. Jorgensen. *Slag cement.*

To ordinary slag cement, which is composed of ground slag and slaked lime, is added a roasted and powdered mixture of ground slag, slaked lime, and water.

582068—May 4, 1897. R. W. Lesley. *Hydraulic cement.*

To produce a slow-setting Portland cement the cement making material, after calcination, and in the form of either clinker or powder, is treated with dilute sulphuric acid.

[illegible]—June 15, 1897. M. W. L. Nahnsen. *Manufacture of cement.*

The residues from the manufacture of sulphate of aluminum are freed from components soluble in water and the remainder mixed with lime, without being burned.

[illegible]—September 14, 1897. W. H. [illegible]. *Method of calcining friable materials.*

The material to be calcined is formed into a tube and continuously projected into the furnace, the heat of which passes up through the tube.

[illegible]—October 26, 1897. A. Kullisen. *Cement manufacture.*

From 3 to 5 per cent of manufactured cement is added to the raw material and the mixture formed into blocks, which are burned and ground.

[illegible]—March 1, 1898. H. H. Pierce. *Process of treating lime.*

Quicklime is slaked to a putty, roasted in the presence of carbonic acid gas, and ground.

[illegible]—June 28, 1898. C. J. Curtis. *Process of making slag cement.*

Burnt lime, to which has been added 3 per cent of hydrochloric acid, is immersed in about 20 per cent of water, thoroughly mixed and combined with 85 per cent of molten slag, and then dried and pulverized.

[illegible]—January 3, 1899. A. D. Elbers. *Process of treating blast-furnace slag for cement.*

Pulverized blast furnace slag is superficially desulphurized by the application of a weak solution of nitric acid, and then alkalized by impregnation with an aqueous solution of sodium carbonate.

620155—February 28, 1899. H. J. Livingston. *Composition for making carbonated, hydraulic lime, cement, or mortar.*

It consists of 100 parts of hydrate of lime, 30 to 40 parts of coke, and 1 part of saccharine or farinaceous matter by weight.

[illegible]—April 4, 1899. H. H. Pierce. *Cement.*

Quicklime is slaked to a putty; pulverized sulphate of lime is then added, the mixture is roasted, and the roasted product is then reduced to a powder.

[illegible]—April 4, 1899. H. H. Pierce. *Treatment of lime.*

Quicklime is slaked to a putty; pulverized carbonate of lime is then added, the mixture is roasted, and the roasted product is reduced to a powder.

[illegible]—November 14, 1899. C. Straub. *Process of treating calcareous rocks.*

Calcined lime is partially hydrated, and then recalcined until all moisture is expelled.

[illegible]—February 20, 1900. W. S. O. Muth. *Manufacture of cement.*

Burnt lime is hydrated with water containing a soluble salt which will evolve oxygen at a high temperature, such as nitrate of soda, and the hydrated lime is mixed with powdered blast-furnace slag, and then calcined.

651683—June 12, 1900. G. M. Westman. *Process of manufacturing lime and carbonic acid.*

The process consists in heating a mixture of carbonic acid and steam, passing this mixture through limestone, drawing off the expelled carbonic acid and lime produced, bringing the expelled carbonic acid in contact with water to convert the latter into steam and form a mixture of steam and carbonic acid, reheating a part of the mixture thus formed, and forcing the mixture back into and through the limestone.

[illegible]—August 7, 1900. L. H. M. Mercheron-Vicat. *Artificial cement.*

Marly limestone is calcined, and then fused under oxidizing conditions, thereby removing the sulphur while in a state of fusion.

[illegible]—February 5, 1901. A. S. Schubert and F. J. Pierce. *Process of producing lime and cement and fixed combustible gases.*

The gases distilled off from a mass of raw cement and fuel are passed through a mass of incandescent carbonaceous material, from which air is excluded, the residuum is subsequently clinkered, the heat evolved in the clinkering process being utilized for distilling and partially burning a subsequent charge.

[illegible]—March 19, 1901. G. M. Westman. *Process of manufacturing lime and carbonic acid.*

This is a continuous process of treating limestone with a highly heated mixture of carbonic acid and steam, consisting in expelling the carbonic acid from the limestone, bringing the hot carbonic acid in contact with water to convert the latter into steam, mixing the steam with the expelled carbonic acid, and then reheating the mixture and again passing it through the limestone, thus producing lime and carbonic acid of maximum purity.

[illegible]—July 9, 1901. W. Lessing. *Process of burning cement, gypsum, etc.*

The raw material is ground, heated to a white heat, and dropped downward against a column of flame; it is then utilized, in its intensely heated condition, to generate steam for the preliminary warming of fresh material.

[illegible]—July 30, 1901. G. Miller. *Process of burning pieces of raw cement.*

Pieces of dried cement are passed successively through a series of drying drums, each containing a plastic mass of raw cement.

[illegible]—September 17, 1901. C. M. Avery. *Process of pulverizing calcium oxide or lime.*

The lime, as it comes from the kiln, is subjected to simultaneous agitation and sifting in the presence of steam.

[illegible]—September [illegible], 1901. F. N. Speak. *Process of treating lime.*

Finely divided quicklime is subjected to the action of steam in a closed chamber, and then brought into contact with carbonic acid gas obtained from a calcining kiln.

685064—October 22, 1901. A. S. Schubert. *Process of producing lime or cement and combustible gases.*

Heated products of the combustion of burning fuel are passed through raw cement material, thereby expelling gaseous matter therefrom, the resultant gases being subsequently passed through a body of highly heated fuel.

[illegible]—December 17, 1901. G. Warren. *Manufacture of cement or similar materials.*

The liquid sludge is run into molds and dried, to form blocks for calcination.

[illegible]—January 21, 1902. J. D. McDonnell. *Cement.*

It consists of water, carbolic acid, nitro-muriatic acid, nitric acid, crushed calcareous rock, sulphate of calcium, and cement of any manufacture.

[illegible]—February 4, 1902. C. E. Eldred. *Method of calcining lime, etc.*

In place of the ordinary pure-air draft, an artificially accelerated draft composed of air and a neutral gaseous diluent—kiln gases—is used to promote combustion, thereby greatly retarding the liberation of the heat units of the fuel and producing a long flame of large volume.

698268—April 22, 1902. O. Friz. *Process of making cement.*

To produce a white cement, a mixture of lime, clay as free as possible from iron, and feldspar is burned to the verge of fusion—that is, beyond the sintering limit

702003—June 10, 1902. F. G. Jordan. *Process of making cement.*

Limestone is decarbonated and siliceous clay mixed therewith while in an incandescent state; the mixture is then ignited in the presence of a hydrating agent, molded, calcined, and ground.

704870—July 15, 1902. J. T. McKim. *Cement.*

A compound to be added to Portland or similar cement, consisting of calcareous ocher, iron ore plant, and litharge, ground and subjected to a heat of 160° F.

705542—July 22, 1902. M. T. J. Ochs. *Plastic composition.*

It consists of a mixture of 2 parts of hydraulic cement, 1 part of powdered silicate of aluminum, and 1 part of powdered carbonate of lime.

705650—July 29, 1902. V. Conti, G. DeGeofrey, and G. LeGall du Terte. *Artificial stone.*

A mixture of 15 parts of aluminum sulphate, 15 parts of pulverized Kieselguhr, 50 parts of calcined magnesia, 25 parts of magnesium chloride, and 75 parts of magnesium sulphate, all by weight, together with inert matter.

706760—August 12, 1902. W. R. Knox. *Hydraulic fireproof cement.*

A ground but unburned mixture composed of about 24 parts of silica, 6½ parts of alumina, 5 parts of magnesia, 60 parts of lime, 3 parts of hydrochloric acid, and 1½ parts of iron oxide.

707788—August 26, 1902. J. Murphy. *Composition of matter.*

It consists of crushed, hard iron slag, pulverized hard-limed cinders, Portland cement, liquor of flints, and water

714842—December 2, 1902. R. F. Wentz. *Art of manufacturing cement.*

Cement ore is calcined by the combustion of pulverized carbon, utilizing also the heat from the gaseous products, derived from the disintegration of highly heated cement clinker when treated with water and air.

CLAY

CLAY.

By Jefferson Middleton.

This report covers the operations of the clay mining industry in the United States during the year 1902. By far the larger portion of the clay mined is used by the miner in the manufacture of clay products, but as the work of winning the clay is such an intimate part of the process of manufacture as to make its segregation impossible, only the clay mined and sold as such has been included in the report. The statistics for the clay working industries were shown in the Twelfth Census Report on Manufactures.

The clay mining industry seems to have received but little attention at previous censuses. Statistics were first shown at the census of 1860, when 5 mines were reported, all in Middlesex county, N. J., with a product valued at $105,660. At the census of 1870, 1 fire clay establishment was reported from Jackson county, Mich., with a product valued at $80,000. At the census of 1880 statistics were presented for 9 kaolin mines—4 in Delaware, 2 in South Carolina, and 1 each in Indiana, Maryland, and New York—reporting 23,277 tons of clay, valued at $200,457. The Eleventh Census contains no statistics for clay mining as a distinct industry.

Clay mining was carried on in 27 states, but in most of them the industry was of minor importance. In only 6 of the states did the product exceed a value of $100,000, and the product for these states was 68.7 per cent of the total value of products for the United States.

The following table is a summary of the statistics for 1902:

Table 1.—*Summary: 1902.*

Number of mines	205
Number of operators	203
Salaried officials, clerks, etc.:	
Number	185
Salaries	$160,506
Wage earners:	
Average number	2,433
Wages	$958,892
Contract work	$13,241
Miscellaneous expenses	$125,873
Cost of supplies and materials	$272,823
Product:	
Quantity, short tons	1,455,357
Value	$2,061,072

While there were 205 mines reported, they were owned by 203 operators, showing that the clay mining industry is as yet largely local, the modern tendency to combination not having affected it. Of the mines, 34 were in New Jersey, 31 in Ohio, and 25 in Missouri. The number in the other states varied from 19 in Pennsylvania to 1 in several of the states.

In addition to the active mines, 61 idle mines were reported, distributed as follows: 12 in Ohio, 6 in Tennessee, 5 in Maryland, 4 each in Georgia and Pennsylvania, 3 each in Colorado, Missouri, North Carolina, and Virginia, 2 each in California, Illinois, Indiana, Kentucky, Massachusetts, and Vermont, and 1 each in Michigan, New Hampshire, New Jersey, New York, South Carolina, and West Virginia. There were also 2 mines—1 each in North Carolina and Florida—at which development work only was reported.

Capital stock of incorporated companies.—Table 2 presents the details of the capitalization of the 45 incorporated companies reporting capitalization. It shows that of the 203 operators of clay mines 52 were incorporated companies, of whom 45 reported an authorized capital stock of $6,947,600. The total number of shares authorized was 660,536, and the total number of shares issued was 341,107, with a par value of $5,275,200. The dividends paid during the year amounted to $59,190. The authorized stock was divided into 650,986 shares of common stock, with a par value of $6,272,600, and 9,550 shares of preferred stock, with a par value of $675,000. Of the common stock, however, only 332,377 shares (par value, $4,637,200) were issued, while 8,730 shares of preferred stock (par value, $638,000) were issued. The bonds issued were 717 in number, with a par value of $331,000, on which the sum of $18,110 was paid as interest. The only states in which companies reported preferred stock were Georgia, Delaware, and New Jersey, while bonds were authorized and issued only in the two last named states and in Pennsylvania. In West Virginia bonds to the value of $15,000 were authorized, but none were issued. In only 1 state (Wisconsin) were assessments levied.

TABLE 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	California.	Colorado.	Delaware.	Georgia.	Illinois.	Kentucky.	Missouri.
Number of incorporated companies	52	2	1	5	1	1	4	2
Number reporting capitalization	45	1	1	5	1	1	4	2
Capital stock and bonds issued	$5,606,200	$200,000	$30,000	$1,146,000	$235,900	$5,000	$25,400	$492,200
Capital stock:								
Total authorized—								
Number of shares	660,536	500,000	30,000	18,300	6,500	100	2,206	5,210
Par value	$6,947,600	$500,000	$30,000	$1,370,000	$650,000	$5,000	$210,600	$521,000
Total issued—								
Number of shares	341,107	200,000	30,000	11,850	2,359	100	254	4,922
Par value	$5,275,200	$200,000	$30,000	$1,140,000	$235,900	$5,000	$25,400	$492,200
Dividends paid	$59,190			$10,000			$7,380	
Common—								
Authorized—								
Number of shares	650,986	500,000	30,000	14,300	6,000	100	2,206	5,210
Par value	$6,272,600	$500,000	$30,000	$970,000	$600,000	$5,000	$210,600	$521,000
Issued—								
Number of shares	332,377	200,000	30,000	7,850	2,079	100	254	4,922
Par value	$4,637,200	$200,000	$30,000	$740,000	$207,900	$5,000	$25,400	$492,200
Dividends paid	$55,690			$10,000			$7,380	
Preferred—								
Authorized—								
Number of shares	9,550			4,000	500			
Par value	$675,000			$400,000	$50,000			
Issued—								
Number of shares	8,730			4,000	280			
Par value	$638,000			$400,000	$28,000			
Dividends paid	$3,500							
Bonds:								
Authorized—								
Number	90,747			2				
Par value	$436,000			$6,000				
Issued—								
Number	717			2				
Par value	$331,000			$6,000				
Interest paid	$18,110			$360				
Assessments levied	$100,000							

	New Jersey.	Ohio.	Pennsylvania.	South Carolina.	West Virginia.	Wisconsin.	All other states.[1]
Number of incorporated companies	9	5	3	5	2	2	7
Number reporting capitalization	9	3	2	4	2	2	5
Capital stock and bonds issued	$1,300,700	$34,000	$1,200,000	$228,000	$75,000	$110,000	$524,000
Capital stock:							
Total authorized—							
Number of shares	25,920	450	11,000	11,500	2,500	200	46,750
Par value	$1,241,000	$45,000	$1,050,000	$250,000	$250,000	$200,000	$625,000
Total issued—							
Number of shares	24,192	340	11,000	11,280	750	110	43,850
Par value	$1,125,700	$34,000	$1,050,000	$228,000	$75,000	$110,000	$524,000
Dividends paid	$15,310		$5,000	$1,500			$20,000
Common—							
Authorized—							
Number of shares	20,870	450	11,000	11,500	2,500	200	46,750
Par value	$1,016,000	$45,000	$1,050,000	$250,000	$250,000	$200,000	$625,000
Issued—							
Number of shares	19,742	340	11,000	11,280	750	110	43,850
Par value	$915,700	$34,000	$1,050,000	$228,000	$75,000	$110,000	$524,000
Dividends paid	$11,810		$5,000	$1,500			$20,000
Preferred—							
Authorized—							
Number of shares	5,050						
Par value	$225,000						
Issued—							
Number of shares	4,450						
Par value	$210,000						
Dividends paid	$3,500						
Bonds:							
Authorized—							
Number	415		90,300		30		
Par value	$175,000		$240,000		$15,000		
Issued—							
Number	415		300				
Par value	$175,000		$150,000				
Interest paid	$8,750		$9,000				
Assessments levied						$100,000	

[1] Includes companies distributed as follows: Connecticut, 1; Florida, 2; Massachusetts, 1; North Carolina, 3.

Delaware, New Jersey, and Pennsylvania are the only states showing a capitalization exceeding $1,000,000.

Employees and wages.—The average number of wage-earners employed during each month in 1902 is shown by states in Table 7. The most active clay mining season was from April to October. This is to be expected when the principal method of mining clay is considered. Probably 90 per cent of the work was done in open pits; this tends to reduce operations in the cold months and in inclement weather. The variation in the number of wage-earners between the months of summer and winter is not as great as might be expected, considering the fact that the work done is almost entirely above ground. The average number of wage-earners, men and boys, for the whole year was 2,433. The largest number of men employed in any one month was 2,624 in June, while the smallest was 2,100 in February. The average number of men employed for the whole year was 2,403. The average number of boys employed during the year was 30, the highest number being 34 in June and July, and the lowest number 27 in October and November. The largest number of men was employed in New Jersey—697 for the entire year, 798 in July, and 590 in February. The average number of men reported for Pennsylvania was 311 for the whole year, with the largest number in June (338), and the smallest in February (274). South Carolina shows an average of 190 for the year, while the average by months ranged from 167 in August to 216 in May. In Delaware the average for the year was 169, while the greatest number, 197, was reported in June and the least, 103, in February.

Table 3 presents the average number of each class of wage-earners employed at specified daily rates of pay in 1902.

TABLE 3.—*Distribution of wage-earners according to daily rates of pay, by occupations: 1902.*

RATE PER DAY (DOLLARS).	All occupations.	Engineers.	Firemen.	Machinists, blacksmiths, carpenters, and other mechanics.	Miners.	Miners' helpers.	Timbermen and track layers.	Boys under 16 years.	All other wage-earners.
Total	2,433	53	19	34	1,648	17	2	30	629
Less than 0.50	11							9	2
0.50 to 0.74	44				1			13	30
0.75 to 0.99	330		1		275		2	5	47
1.00 to 1.24	495	6	2	7	206			3	270
1.25 to 1.49	871	2	3	5	730	2			129
1.50 to 1.74	321	24	10	12	231	8			36
1.75 to 1.99	89	2	2		34	3			48
2.00 to 2.24	121	11	1	8	76	4			21
2.25 to 2.49	65	2		1	53				9
2.50 to 2.74	68	4		1	29				34
2.75 to 2.99	7				7				
3.00 to 3.24	10	1			6				3
3.25 to 3.49	1	1							

Of the 2,433 wage-earners of all occupations, 871, or 35.8 per cent, received between $1.25 and $1.49 per day; 495, or 20.3 per cent, between $1 and $1.24; 330, or 13.6 per cent, between 75 and 99 cents; and 321, or 13.2 per cent, between $1.50 and $1.74.

Of the total number, 1,648, or 67.7 per cent, were miners, of whom 730, or 44.3 per cent, received between $1.25 and $1.49 per day, and 231, or 14 per cent, between $1.50 and $1.74; while 276, or 16.7 per cent, received less than $1.

The wage-earners next in number to miners were reported as "all other wage-earners." Of these there were 629, consisting largely of unskilled workmen or common laborers, as is indicated by the low rates shown in the table—399, or 63.4 per cent, having been paid from $1 to $1.49 per day. The other classes of occupations were numerically small.

The rates of pay of engineers, firemen, and mechanics averaged somewhat higher than the rates for miners, while the rates paid to boys ranged from less than 50 cents up to from $1 to $1.24.

Mechanical power.—The total horsepower reported for the industry was 4,478, of which 3,942, or 88 per cent, was steam, the remainder being divided between gas and gasoline engines, water wheels, and "other power." Power is used to a less extent, proportionally to production, in the mining of clay than in many of the other mining industries, clay being taken usually from open cuts, with pick and spade, and without the use of machines.

Production.—Table 4 shows the production of clay from 1897 to 1902, inclusive, by varieties.

TABLE 4.—QUANTITY AND VALUE OF EACH KIND OF CLAY PRODUCED: 1897 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

KIND	1902		1901		1900		1899		1898		1897	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
All kinds	1,465,357	$2,061,072	1,367,170	$2,576,932	1,221,660	$1,840,377	843,279	$1,645,328	565,460	$1,384,766	563,115	$978,448
Raw	1,203,369	1,319,174	1,019,163	1,273,684	1,028,643	1,207,160	843,279	1,645,328	565,460	1,384,766	563,115	978,448
Prepared	261,988	741,898	348,007	1,303,248	193,017	633,217						
Kaolin	123,813	646,777	97,253	584,523	60,114	397,286	97,107	471,282	100,534	496,979	68,743	367,080
Raw	58,343	189,603	37,456	141,899	22,554	108,220	97,107	471,282	100,534	496,979	68,743	367,080
Prepared	65,470	457,174	59,797	442,624	37,560	289,066						
Ball	50,527	171,086	[1]21,008	[1]68,907	21,381	91,983	22,762	109,369	101,111	154,743	112,926	213,566
Raw	30,000	68,524	21,008	68,907	13,976	53,850	22,762	109,369	101,111	154,743	112,926	213,566
Prepared	20,527	102,562	([1])	([1])	7,405	38,133						
Fire	926,896	891,185	929,749	1,514,508	845,559	947,993	478,996	826,919	352,612	672,362	381,446	397,802
Raw	774,532	736,055	680,793	746,956	714,403	685,927	478,996	826,919	352,612	672,362	381,446	397,802
Prepared	152,364	155,130	248,956	767,562	131,156	262,066						
Stoneware	91,579	113,842	92,229	114,613	93,529	94,705						
Raw	87,147	105,182	87,829	101,753	88,815	83,843						
Prepared	4,432	8,660	4,400	12,860	4,714	10,862						
Terra cotta (raw)	56,453	54,213			45,077	50,769	91,661	101,744				
Pipe	94,874	74,856			42,532	36,134	89,953	57,702				
Raw	94,874	74,856			42,407	35,604	89,953	57,702				
Prepared					125	530						
Miscellaneous	117,215	109,113	226,931	294,381	118,468	221,507	62,800	78,312	31,193	60,682		
Raw	[2]108,020	[2]90,741	192,077	214,169	101,411	188,947	62,800	78,312	31,193	60,682		
Prepared	9,195	18,372	34,854	80,212	12,067	32,560						

[1] Prepared ball clay included in "miscellaneous."
[2] Includes 39,157 tons of sand, valued at $35,956, produced in connection with the mining of clay.

It is possible that the figures for some of the years are not strictly comparable, because they may include clay sold, in the raw or the prepared state, by those whose principal business was the manufacture and sale of clay products and not the production of clay. This table shows that the production of clay increased from 563,115 tons in 1897 to 1,455,357 tons in 1902, a gain of 892,242 tons, or 158.4 per cent, while the value increased from $978,448 in 1897 to $2,061,072 in 1902, a gain of $1,082,624, or 110.6 per cent. It is probable that the figures for the first two or three years reported by the Survey are somewhat below the actual output, because they were collected by correspondence—a method by which it takes usually two or three years to secure satisfactory results.

While the quantity of the product for 1902 was the largest recorded, being greater by 88,187 tons, or 6.5 per cent, than in 1901, the value of the product decreased from $2,576,932 in 1901 to $2,061,072 in 1902, a loss of $515,860, or 20 per cent. This decrease in value was due largely to a marked decline in the value of prepared fire clay, which showed a decrease of 38.8 per cent in quantity and of 79.8 per cent in value.

Of the 1,455,357 tons of clay mined in 1902, 1,203,369 tons, or 82.7 per cent, were sold without any preparation whatever after mining, while 251,988 tons, or 17.3 per cent, were prepared at the mine by washing, by grinding, or in some other manner. In 1901, 74.5 per cent was sold raw and 25.5 per cent was prepared at the mine. The average value of all clay at the mine in 1902 was $1.42 per ton; the value of the raw clay was $1.10, and of the prepared, $2.94 per ton. In 1901 these average values were $1.89, $1.25, and $3.74, respectively.

Rank of states.—Table 5 shows the distribution of the value of the clay produced during 1902, by states, ranked according to the value of their product.

New Jersey was by far the most important clay mining state, its product being valued at $612,721, or 29.7 per cent of the total. Pennsylvania ranked second with a product valued at $288,811, or 14 per cent; Delaware was third, with a value of $171,714, or 8.3 per cent; and Missouri, South Carolina, and Ohio were fifth, sixth, and seventh, in the order named, with products valued at $134,862, $107,325, and $101,305, respectively, or 6.5 per cent, 5.2 per cent, and 4.9 per cent. The product of these six states was valued at $1,416,738, or 68.6 per cent of the total. In "all other states" are included, however, two rather important clay producing states, namely, Florida and North Carolina. In these states the clay produced was valued at $221,833, or 87 per cent of the total for "all other states," and 10.8 per cent of the total for the United States. The remaining states were of but relatively small importance, none producing clay valued at as much as $100,000.

TABLE 5.—*Rank of states according to value of clay produced: 1902.*

STATE.	Rank.	Value of product.	Per cent of total.
United States	......	$2,061,072	100.0
New Jersey	1	612,721	29.7
Pennsylvania	2	288,811	14.0
Delaware	3	171,714	8.3
Florida	4	(a)	......
Missouri	5	134,862	6.5
South Carolina	6	107,325	5.2
Ohio	7	101,305	4.9
North Carolina	8	(a)	......
Georgia	9	76,480	3.7
Colorado	10	67,434	3.3
Kentucky	11	45,296	2.2
West Virginia	12	43,286	2.1
Illinois	13	38,465	1.9
Tennessee	14	37,151	1.8
California	15	24,415	1.2
Wisconsin	16	23,178	1.1
Alabama	17	19,712	1.0
Connecticut	18	(a)	......
New York	19	14,525	0.7
Maryland	20	10,063	0.5
Indiana	21	(a)	......
Vermont	22	(a)	......
Utah	23	(a)	......
Michigan	24	(a)	......
Massachusetts	25	(a)	......
Texas	26	455	(b)
Washington	27	(a)	......
All other states		254,854	12.4

(a) Included in "all other states" to avoid disclosing individual returns.
(b) Less than one-tenth of 1 per cent.

Imports.—The following table is a statement of the clay imported into the United States from 1885 to 1902:

TABLE 6.—IMPORTS OF CLAY, CLASSIFIED BY KINDS, 1885 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

CALENDAR YEAR.	TOTAL.		KAOLIN, OR CHINA CLAY.		ALL OTHER CLAY.					
					Unwrought.		Wrought.		Common blue.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1885	23,916	$195,460	10,626	$88,722	9,736	$76,889	3,554	$29,849	......	......
1886	31,984	257,698	16,500	123,073	13,730	113,875	1,754	20,750	......	......
1887	45,318	303,052	25,486	141,300	17,645	139,465	2,187	22,287	......	......
1888	45,586	307,989	18,170	102,000	20,684	152,724	6,732	53,265	......	......
1889	47,272	321,492	19,843	113,558	19,287	145,963	8,142	61,971	......	......
1890	53,950	454,770	29,923	270,141	21,049	155,486	2,978	29,143	......	......
1891	62,292	469,629	39,901	294,458	16,094	115,689	6,297	59,482	......	......
1892	79,323	655,011	49,468	375,175	20,182	155,047	4,331	64,818	5,342	$59,971
1893	75,156	606,658	49,713	374,460	14,949	113,029	6,090	67,280	4,404	51,889
1894	83,157	653,949	62,715	465,501	13,146	98,776	4,768	60,786	2,528	28,886
1895	102,895	758,184	75,447	531,714	18,410	125,117	5,160	60,775	3,878	40,578
1896	99,814	735,506	76,718	536,081	13,319	88,029	4,814	56,701	4,963	54,695
1897	93,744	672,881	71,908	493,431	9,405	76,214	7,839	52,282	4,592	50,954
1898	108,440	758,268	85,566	574,325	16,150	98,414	1,112	24,909	5,612	58,290
1899	123,074	872,962	92,521	613,717	19,614	118,629	1,710	31,998	9,229	108,618
1900	144,107	962,367	111,558	698,710	21,626	126,213	3,196	45,431	7,727	92,013
1901	157,196	959,777	117,776	653,379	27,797	156,838	5,706	75,721	6,136	73,839
1902	168,551	1,154,805	133,062	883,072	25,831	138,052	2,680	47,093	6,978	86,588

A detailed summary of the clay mining industry for 1902 is given in Table 7.

DESCRIPTIVE.

Popularly, clay is any earthy substance which, if mixed with water and molded, will retain its shape after drying, and which upon subjection to high temperature loses its plasticity and becomes hard and brittle.

Technically, pure clay or kaolinite, which is the basis of all clay, is a hydrated silicate of aluminum, expressed by the formula $Al_2O_3 2SiO_2, 2H_2O$. All clay in its natural state contains more or less impurities, the kind and quantity of which determine its character; from purest varieties, called kaolin, clays range through all stages of impurity down to a point where the material contains so little kaolinite that it can not be classified as clay at all.

Clay is ordinarily classified as kaolin, ball clay, fire clay, vitrified ware clay, and brick clay; there are also slip clay, and paper clay. Fire clay includes clays used for stoneware and for terra cotta, which are reported separately by the Geological Survey. Vitrified ware clay includes the pipe clay reported by the Survey.

In the following description of the physical and chemical properties of the several kinds of clay, the chemical analysis has been supplemented, wherever possible, by what is called the rational analysis. The ordinary quantitative chemical analysis treats clay as a mixture of oxides, although the elements may be present in entirely different combinations, such as silicates, carbonates or hydrates, sulphates, etc. The nature of these combinations is of importance. For example, silica in the form of quartz, which is infusible, will decrease the shrinkage and up to certain temperatures increase the refractoriness; but if present as a component of feldspar, it serves the purpose of a flux and somewhat increases the plasticity. The advantage of the rational analysis is that it resolves the clay into its mineral components, affording an insight into the physical properties—as fusibility, refractoriness—of the material. This is frequently a matter of far greater importance than the chemical composition; for instance, two clays of the same rational composition will behave much alike if burned under the same conditions, even though they may differ in chemical composition.

Kaolin.—Kaolin is a white burning, nonplastic, highly refractory residual clay used in the manufacture of china and other white wares; it must be practically free from iron, as a very small quantity would cause the ware to become discolored in burning. The chief producing states are Pennsylvania, Delaware, North Carolina, and South Carolina. The following is an analysis of a washed sample of the kaolin from North Carolina, which is one of the best known and most widely used.

Analysis of washed kaolin from North Carolina.[1]

	Per cent.
Silica	45.70
Alumina	40.61
Ferric oxide	1.39
Lime	0.45
Magnesia	0.09
Alkalies	2.82
Moisture	0.35
Water—loss on ignition	8.98
	100.39
Free sand	3.19
Total fluxes	4.75
Specific gravity	2.43

The rational analysis is as follows:

Clay substance	96.81
Quartz	0.07
Feldspar	3.12
	100.00

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[1] North Carolina Geological Survey, Bulletin No. 13, page 61.

Ball clay.—Ball clay is a white burning, plastic, sedimentary clay, used with kaolin to afford plasticity to the body in the manufacture of white ware, and often incorrectly called kaolin. The distinguishing characteristic of this clay is its plasticity. The chief producers of ball clay for sale are Florida, New Jersey, and Kentucky.

The following is an analysis of ball clay from Florida:

Analysis of ball clay from Florida.[1]

	Per cent.
Silica	46.11
Alumina	39.55
Ferric oxide	0.35
Magnesia	0.13
Sulphuric oxide	0.07
Titanic oxide	1.20
Water	13.78
	101.19

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[1] United States Geological Survey, Professional Paper, No. 11, page 39.

Fire clay.—The term fire clay is a rather broad one, embracing not only the high-grade clays used for the manufacture of refractory material of all kinds, but also the more or less impure varieties used for stoneware, terra cotta, and yellow and Rockingham ware. Glass-house supplies, which must be highly refractory, are made from an especially high grade of this clay. Fire clay is subdivided into flint, or nonplastic, and plastic clay. The mining of fire clay for sale is most extensively carried on in New Jersey, Missouri, Pennsylvania, and Ohio.

Analyses of various fire clays.

[Chemical.]

CONSTITUENTS.	FIRE CLAY FROM NEW BRIGHTON, PA.	GLASS-POT CLAY FROM LAYTON STATION, PA.	STONEWARE CLAY.[1]	ROCKINGHAM AND YELLOW WARE CLAY.[1]
	Per cent.	Per cent.	Per cent.	Per cent.
Silica	61.75	64.89	71.58	60.50
Alumina	23.66	24.08	18.31	25.53
Ferrous oxide	1.93	0.21		
Ferric oxide		0.29	1.09	1.66
Lime	0.46	0.41	0.40	0.38
Magnesia	0.35	0.19	0.62	1.19
Alkalies	2.42	1.08	[2] 2.96	1.76
Titanic oxide	1.78			0.54
Manganous oxide			Trace.	0.33
Water	7.20	9.29	5.95	7.98
Total	99.55	100.39	100.91	99.87

[Rational.]

Clay substance			85.42	76.05
Quartz			11.41	19.54
Feldspathic detritus			4.08	4.28
Total			100.91	99.87

[1] Chemistry of Pottery, by Karl Langenbeck.
[2] Combining weight 47 per cent.

Vitrified ware clay.—Clays for vitrified wares, such as sewer pipe, electric conduits, and vitrified paving brick, are those in which the proportion of fluxing impurities is sufficient to allow the clay to vitrify at a moderately low temperature, but not to cause the ware to become soft under the pressure of a column of some height and considerable weight. The following table shows the range of the constituents of clays used for making vitrified paving brick, together with an average analysis of such clays:

Analysis of vitrified paving brick clay.[1]

	Minimum (per cent).	Maximum (per cent).	Average (per cent).
Silica	49.00	75.00	56.00
Alumina	11.00	25.00	22.50
Ferric oxide	2.00	9.00	6.70
Lime	0.20	3.50	1.20
Magnesia	0.10	3.00	1.40
Alkalies	1.00	5.50	3.70
Ignition loss (mainly water)	3.00	13.00	7.00

[1] Vitrified Paving Brick, by H. A. Wheeler, page 18.

Brick clay.—Brick clays are divided into those used for common and for pressed and ornamental brick. Red earthenware, such as flowerpots, is also made of brick clay. Clays suitable for the manufacture of common brick are located in every state and almost every county in the Union. Of all clays these are usually the most impure, often containing a rather high percentage of lime. Lime in a finely divided state is not harmful; but in the form of limestone pebbles it is very injurious to the finished product, as the process of burning converts these pebbles into quicklime, which is apt to slack, thus breaking the brick, upon being exposed to the atmosphere. This difficulty is sometimes overcome by passing the clay through a pulverizer, which crushes the pebbles, or by screening it to remove them. The following table shows the range of the constituents of clays used in the manufacture of common building brick, together with an average analysis of such clays:

Analysis of common brick clay.[1]

	Minimum (per cent).	Maximum (per cent).	Average (per cent).
Silica	34.35	90.877	49.27
Alumina	22.14	44.60	22.774
Ferric oxide	0.125	33.12	5.311
Lime	0.024	23.20	2.017
Magnesia	0.02	11.03	2.66
Alkalies	0.17	15.32	2.768
Water	0.05	13.60	5.749
Moisture	0.17	9.61	2.502

[1] New York State Museum, Bulletin No. 35, page 689.

Pressed brick and ornamental brick require a higher grade of clay, the buff varieties being made sometimes from a refractory or semirefractory clay. The buff color in refractory clay is due to the low percentage of iron; in other clays, notably the Milwaukee clay, from which is made, probably, the best known buff or cream brick, it is due to a large percentage of lime, which enters into chemical combination with the iron, thus neutralizing its coloring effect.

Slip clay.—Slip clay is used in glazing low grade products such as earthenware and stoneware. It must fuse at a low temperature and produce a glaze of even color. The clay generally used for this purpose is mined near Albany, N. Y., and hence is known as Albany slip. It produces a dark brown glaze, and is shipped to almost every state in the Union.

Paper clay.—Paper clay is used, as its name indicates, in the manufacture of paper. As clay used for this purpose is not molded or fired, plasticity, fusibility, and vitrifying qualities need not be considered; hence any pure white, smooth, gritless clay can be used. Where the clay is suitable in color, but gritty, the grit is sometimes washed out. In the United States paper clays are mined in Delaware, Georgia, Maryland, Pennsylvania, and Wisconsin.

The following is an analysis of so-called kaolin from Wisconsin, used in paper manufacture:

Analysis of paper clay from Wisconsin.[1]

	Per cent.
Silica	52.41
Alumina	34.10
Ferric oxide	0.15
Lime	0.05
Magnesia	0.12
Alkalies	0.64
Titanic oxide	0.80
Combined water	11.89
	100.16

[1] Wisconsin Geological and Natural History Survey, Bulletin No. 7, page 272.

Methods of mining.—There are several methods of mining clay, but only two are generally followed, viz, open pit and underground mining. Open pit mining is conducted in several ways—with pick and shovel, with a scraper, or by falling the clay, that is, by undermining it and letting it fall. Sometimes explosives are used for the last-named purpose.

In underground clay mining the methods of working are the same as those usually followed in coal mining, namely, by shaft or tunnel, with drifts, slopes, and chambers; there are, however, comparatively few deep mines in the clay industry, except where the clay is mined in connection with coal. Kaolin is sometimes mined by sinking through the vein a round shaft, the sides of which are timbered.

Preparation.—The commoner grades of clay are generally sold as mined, because to prepare them for the market in any way would add so greatly to their cost as to make them unprofitable. Even the common clays, however, are sometimes screened or ground to get rid of limestone pebbles or other small stones; screening removes them mechanically, while grinding overcomes their bad effects through comminution. In this country the common clays are not washed. The kaolins and ball clays are, however, sometimes washed at the mines, but they are again washed or prepared at the pottery before being manufactured into white ware.[1] Another method of separating the clay from its undesirable impurities is by fans. This method can only be employed where the impurities are in the form of coarse particles or grains of sand, and consists in first grinding the clay to a very fine powder, after which it is carried to a flue through which a strong current of air is forced; this immediately carries the finer particles to the end of the flue where they are dropped into a bin. The coarser particles are dropped into the flue and carried back to the pulverizer to be ground over again. In the manufacture of pottery, and also of brick by the dry press process, the clay is cured, or weathered, often for months, before being used.

Uses.—Clay is used most extensively in the manufacture of common building brick; next in importance, as measured by the quantity of material consumed, is front or pressed brick, with its almost limitless variety in color and shape. Then there are vitrified brick, with a large and growing field of usefulness, and fire brick, the shape and utility of which are almost without limit, stove lining being an important subdivision. Other important products are drain tile, sewer pipe, ornamental terra cotta, fireproofing, roofing tile, flooring tile, and encaustic tile.

In addition there are assayers' supplies, boiler and locomotive tile and tank blocks, building blocks, burnt clay ballast, chemical brick, patent chimney brick, chimney pipes and tops, clay furnaces and retorts, conduits for underground wires, crucibles, cupola bricks, fence posts and fence post stubs, flue linings, frost proof cellar brick, gas logs and settings, glass-house furnace blocks, grave markers, muffles, porous cups, runner brick, sidewalk tile, souvenirs, stone pumps, terra cotta vases, tile mantels, wall coping, washboards, and well brick and tile.

In addition to the well-known pottery products of clay, such as red earthenware, stoneware, yellow and Rockingham ware, and the various grades of white ware from C. C. ware to china, the following wares also are made of clay: Acid proof tanks, art and chemical pottery, bath tubs, caster wheels, electrical supplies, faience glass pots, insulators, jardinieres, lavatories, pins, stilts and spurs for potters' use, porcelain hardware trimmings, shuttle eyes and thread guides, pump stands, and wash tubs.

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[1] For description of methods of washing clays, see New York State Museum, Bulletin No. 35.

TABLE 7.—DETAILED

		United States.	Alabama.	California.	Colorado.	Delaware.	Georgia.	Illinois.
1	Number of mines	266	5	6	4	6	7	8
2	Number of operators[1]	263	5	6	4	6	7	7
	Character of ownership:							
3	Individual	115	5	4	3	1	1	5
4	Firm	76					2	1
5	Incorporated company	72		2	1	5	4	1
	Salaried officials, clerks, etc.:							
6	Total number	191		4	3	13	19	2
7	Total salaries	$150,505		$3,558	$2,430	$12,740	$12,320	$1,200
	General officers—							
8	Number	50				6	13	
9	Salaries	$60,285				$6,000	$8,700	
	Superintendents, managers, foremen, surveyors, etc.—							
10	Number	91		3	1	6	6	1
11	Salaries	$67,492		$2,658	$900	$6,020	$3,620	$600
	Foremen below ground—							
12	Number	25			2			
13	Salaries	$8,761			$1,530			
	Clerks—							
14	Number	25		1		1		1
15	Salaries	$13,967		$900		$720		$600
	Wage-earners:							
16	Aggregate average number	2,483	33	17	50	169	136	42
17	Aggregate wages	$958,892	$9,634	$11,680	$32,642	$69,472	$37,333	$19,602
	Above ground—							
18	Total average number	2,089	33	17	14	102	136	36
19	Total wages	$779,181	$9,634	$11,680	$8,950	$43,819	$37,333	$17,075
	Engineers, firemen, and other mechanics—							
20	Average number	106	2			14	3	
21	Wages	$50,580	$525			$6,679	$1,354	
	Miners—							
22	Average number	1,438	25	13	11	51	58	21
23	Wages	$522,896	$7,813	$8,680	$7,030	$21,140	$15,555	$9,200
	Boys under 16 years—							
24	Average number	30					7	
25	Wages	$5,548					$1,124	
	All other wage-earners—							
26	Average number	515	6	4	3	37	68	15
27	Wages	$200,157	$1,296	$3,000	$1,920	$16,000	$19,300	$7,875
	Below ground—							
28	Total average number	394			36	67		6
29	Total wages	$179,711			$23,692	$25,653		$2,527
	Miners—							
30	Average number	291			19	22		4
31	Wages	$129,695			$12,108	$8,800		$1,840
	Miners' helpers—							
32	Average number	17			4			2
33	Wages	$8,611			$2,384			$687
	All other wage-earners[2]—							
34	Average number	86			13	45		
35	Wages	$41,405			$9,200	$16,853		
	Average number of wage-earners at specified daily rates of pay:							
	Engineers—							
36	$1.00 to $1.24	6						
37	$1.25 to $1.49	2						
38	$1.50 to $1.74	24	2			8	1	
39	$1.75 to $1.99	2						
40	$2.00 to $2.24	11				1		
41	$2.25 to $2.49	2						
42	$2.50 to $2.74	4					1	
43	$3.00 to $3.24	1						
44	$3.25 to $3.49	1						
	Firemen—							
45	$0.75 to $0.99	1					1	
46	$1.00 to $1.24	2						
47	$1.25 to $1.49	3						
48	$1.50 to $1.74	10				2		
49	$1.75 to $1.99	2						
50	$2.00 to $2.24	1						
	Machinists, blacksmiths, carpenters, and other mechanics—							
51	$1.00 to $1.24	7						
52	$1.25 to $1.49	5						
53	$1.50 to $1.74	12				2		
54	$2.00 to $2.24	8				1		
55	$2.25 to $2.49	1						
56	$2.50 to $2.74	1						
	Miners—							
57	$0.50 to $0.74	1						
58	$0.75 to $0.99	275			1		57	
59	$1.00 to $1.24	286	25					6
60	$1.25 to $1.49	730				68		10
61	$1.50 to $1.74	232				5	1	2
62	$1.75 to $1.99	34		6				
63	$2.00 to $2.24	76		5	2			7
64	$2.25 to $2.49	53			23			
65	$2.50 to $2.74	29		2	3			
66	$2.75 to $2.99	7			1			
67	$3.00 to $3.24	6						
	Miners' helpers—							
68	$1.25 to $1.49	2						2
69	$1.50 to $1.74	8						
70	$1.75 to $1.99	3						
71	$2.00 to $2.24	4			4			
	Timbermen and track layers—							
72	$0.75 to $0.99	2						
	Boys under 16 years—							
73	Less than $0.50	9					4	
74	$0.50 to $0.74	13					3	
75	$0.75 to $0.99	5						
76	$1.00 to $1.24	3						

[1] Includes operators distributed as follows: Connecticut, 1; Florida, 2; Indiana, 2; Massachusetts, 1; Michigan, 1; North Carolina, 3; Utah, 1; Vermont, 2; Washington, 1.

SUMMARY: 1902.

Kentucky.	Maryland.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	South Carolina.	Tennessee.	Texas.	West Virginia.	Wisconsin.	All other states [1]	
5	6	27	33	7	31	19	8	9	3	4	3	14	1
5	6	26	33	7	31	19	8	9	1	4	3	14	2
1	6	12	22	5	21	8	[illegible]	9	[illegible]	2	1	[illegible]	3
		11	3	2	1	8						1	4
4		2	9			6	1			2	2	7	5
3	1	20	[illegible]	5	13	32	11	4		1	2	29	6
$3,200	$300	$10,115	$26,011	$2,375	[illegible]	[illegible]	[illegible]	$1,000		$720	[illegible]	[illegible]	7
2		5	7	1	3	7	2				[illegible]	[illegible]	8
$2,100		$3,000	$5,700	$225	$1,000	$17,000	$1,050				[illegible]	[illegible]	9
2		10	20	4	4	11	1	3			1	[illegible]	10
$800		[illegible]	[illegible]	$2,350	$2,709	[illegible]	[illegible]	$1,800			[illegible]	[illegible]	11
		4			2	4				1		2	12
		$1,861			[illegible]	[illegible]				$720		[illegible]	13
	[illegible]	3	8		2	1	2	1				5	14
	$200	$1,028	$5,000		[illegible]	[illegible]	[illegible]	$900				[illegible]	15
18	21	120	[illegible]	15	120	312	198	46		11	30	328	16
$17,080	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$45,115	[illegible]		[illegible]	[illegible]	[illegible]	17
18	21	78	702	14	67	228	198	46		11	30	[illegible]	18
$17,080	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$45,115	$12,140		[illegible]	$16,150	[illegible]	19
2	1	1	17		3	16	10			[illegible]	1	27	20
$780	$200	$800	$2,000		[illegible]	$9,120	[illegible]			[illegible]	[illegible]	[illegible]	21
16	10	40	[illegible]	13	19	[illegible]	[illegible]	91			13	5	22
$17,500	$2,254	$15,408	[illegible]	$6,071	[illegible]	[illegible]	$29,142	[illegible]			[illegible]	[illegible]	23
			5			1	8				[illegible]	7	24
			$1,184			$300	$1,150				[illegible]	$1,180	25
[illegible]	1	37	7	1	10	88	19	25		7	[illegible]	103	26
$770	[illegible]	$21,175	$6,331	$220	[illegible]	[illegible]	$11,761	$6,200		[illegible]	$7,100	[illegible]	27
		12			15	11				27	2	[illegible]	28
		$25,707			[illegible]	[illegible]				[illegible]	$600	[illegible]	29
		20			58	5				18	2	[illegible]	30
		$17,200			[illegible]	[illegible]				$12,332	[illegible]	[illegible]	31
		8			1								32
		$4,100			[illegible]								33
	[illegible]	8			3	[illegible]				[illegible]			34
	[illegible]	$4,102			$2,501	[illegible]				$6,534			35
1							3					2	36
						2	1						37
			1		1							8	38
							1						39
	1		2		2	1				2	2		40
		1			1								41
			1		1	1							42
			1										43
			1										44
													45
			2									2	46
1			2										47
			2			2						4	48
					1					1			49
											1		50
							3					1	51
			2				2						52
			3									5	53
			1			4					1	1	54
			1										55
												1	56
								1					57
		2					150					85	58
32	11	11	15		5	3	1	22				20	59
1	4	22	708	6	15	9							60
16		10	77	4	15	41				1	21	25	61
	1		21	1	6								62
		8	21	2	21	10							63
		1			6	3				17			64
		3	20		1								65
		6											66
			7										67
													68
		8											69
					3								70
													71
								2					72
							5						73
							3					7	74
			5										75
						1					2		76

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[1] Includes timbermen and track layers.

TABLE 7.—DETAILED

		United States.	Alabama.	California.	Colorado.	Delaware.	Georgia.	Illinois.
	Average number of wage-earners at specified daily rates of pay—Con.							
	All other wage-earners—							
77	Less than $0.50	2						
78	$0.50 to $0.74	30						
79	$0.75 to $0.99	47	6				39	
80	$1.00 to $1.24	270					29	
81	$1.25 to $1.49	129				78		
82	$1.50 to $1.74	56				1		
83	$1.75 to $1.99	48				2		15
84	$2.00 to $2.24	21		1	6			
85	$2.25 to $2.49	9						
86	$2.50 to $2.74	34		3	10	1		
87	$3.00 to $3.24	3						
	Average number of wage-earners employed during each month:							
	Men 16 years and over—							
88	January	2,179	25	13	52	106	111	44
89	February	2,100	25	14	52	108	112	42
90	March	2,231	31	16	54	143	114	40
91	April	2,405	28	21	51	189	120	43
92	May	2,575	32	21	51	195	142	42
93	June	2,624	32	20	51	197	145	42
94	July	2,604	37	20	51	176	168	41
95	August	2,568	36	20	51	185	107	41
96	September	2,480	39	19	48	181	106	41
97	October	2,472	39	15	48	195	135	42
98	November	2,393	36	15	44	190	139	42
99	December	2,295	36	11	44	168	146	44
	Boys under 16 years—							
100	January	28					7	
101	February	28					7	
102	March	28					7	
103	April	28					7	
104	May	33					7	
105	June	34					7	
106	July	34					7	
107	August	33					7	
108	September	32					7	
109	October	27					7	
110	November	27					7	
111	December	24					7	
	Contract work:							
112	Total cost	$13,240			$7,150			
113	Number of employees	36			13			
	Miscellaneous expenses:							
114	Total	$126,873	$3,866	$1,656	$7,637	$19,590	$3,017	$1,999
115	Royalties and rent of mine and mining plant	$59,387	$3,785	$1,656	$7,314	$8,589	$100	$1,035
116	Rent of offices, taxes, insurance, interest, and other sundries	$67,486	$81		$323	$11,001	$2,917	$964
117	Cost of supplies and materials	$272,823	$1,966	$910	$5,608	$27,235	$15,500	$3,916
	Product:[1]							
118	Quantity, short tons	1,455,357	10,065	23,483	75,018	125,310	18,595	52,152
119	Value	$2,061,072	$19,742	$24,445	$67,434	$171,714	$76,180	$58,463
	Power owned:							
120	Total horsepower	4,478	10			353	99	76
	Engines—							
	Steam—							
121	Number	98	1			9	3	3
122	Horsepower	3,942	10			345	90	76
	Gas or gasoline—							
123	Number	2				1		
124	Horsepower	18				8		
	Water wheels—							
125	Number	1						
126	Horsepower	5						
	Other power—							
127	Number	22					9	
128	Horsepower	513					9	

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[1] Includes 39,157 tons of sand, valued at $35,966, produced in connection with the mining of clay. Of this amount 7,120 tons, valued at $9,330, were mined in Ohio, and 32,037 tons, valued at $26,636, in Pennsylvania.

CLAY.

SUMMARY: 1902—Continued.

Kentucky.	Maryland.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	South Carolina.	Tennessee.	Texas.	West Virginia.	Wisconsin.	All other states.	
	2												77
							30						78
2													79
1	1	1				16	11	18		2		158	80
	1	3	1	1	1	32	3			5	6		81
		3	7			7		3		6	3	6	82
		11	5		12	2				1			83
		8				4	2						84
					1					8			85
		19				1							86
						3							87
46	14	115	591	5	84	277	198	43		39	9	341	88
46	14	112	590	5	94	274	193	43		39	9	334	89
47	20	109	617	5	105	305	203	43		40	9	330	90
52	21	99	699	6	125	316	211	46		40	14	330	91
51	23	117	762	8	132	319	216	38		41	61	324	92
59	23	119	777	13	131	338	210	38		40	69	320	93
53	23	118	798	17	127	331	169	34		42	76	323	94
60	22	125	787	31	146	337	167	52		42	66	293	95
46	23	128	754	32	149	321	172	72		41	36	292	96
41	24	132	691	29	135	316	182	56		43	25	324	97
41	24	138	662	11	111	311	182	65		42	24	316	98
34	21	129	636	6	100	290	177	45		48	10	322	99
			1			1	8					8	100
			4			1	8					8	101
			4			1	8					8	102
			4			1	8					8	103
			5			1	8				1	8	104
			5			1	8				6	7	105
			6			1	8				5	7	106
			6			1	8					6	107
			6			1	8				4	6	108
			5			1	8					8	109
			5			1	8					6	110
			6			1	8					6	111
$4,000		$77			$1,414	$500							112
15		3			4	1							113
$1,546	$256	$11,704	$19,403	$1,067	$7,072	$13,825	$3,185	$3,745	$150	$1,618	$1,225	$24,292	114
$897	$245	$6,264	$6,939	$400	$3,476	$6,445		$60			$877	$11,305	115
$649	$11	$5,440	$12,464	$687	$3,596	$7,380	$3,185	$3,685	$150	$1,618	$348	$12,987	116
$10,250	$580	$11,123	$67,476	$1,056	$12,444	$42,249	$11,612	$767		$10,420	$3,092	$46,589	117
26,562	8,882	121,601	494,800	8,909	142,440	161,546	29,136	14,050	510	57,506	2,735	52,958	118
$44,260	$10,055	$134,862	$612,721	$14,586	$101,305	$288,811	$107,325	$27,171	$455	$45,266	$22,178	$254,854	119
10	50	186	383	6	292	1,398	353	20		255	115	650	120
1		6	16	6	4	10	8	2		4	3	14	121
10		132	383	6	283	1,088	313	20		295	115	825	122
						1							123
						10							124
												1	125
												25	126
	1	2				5	2					3	127
	56	64				240	40					100	128

ABRASIVE MATERIALS

ABRASIVE MATERIALS.

By Joseph Hyde Pratt.

The mining of abrasive materials forms a very important industry among the minor minerals, on account of their close connection with all manufacturing industries. As a whole, these abrasive materials are but little understood, although they are of widespread use. No manufacturing plant, machine shop, blacksmith shop, farm, or household is without some form of abrasive, so that these materials are perhaps in as universal use as any group of minerals. While the abrasive materials vary widely in character and occurrence, they can readily be grouped together and considered under one head on account of the similarity of their use. The natural products that are used for abrasive purposes are as follows: Buhrstones and millstones (conglomerate and granite); corundum and emery; crystalline quartz; garnet; grindstones and pulpstones (sandstone); infusorial earth, tripoli, and pumice; and oilstones, whetstones, and scythestones (sandstone and schist).

The crystalline quartz included in this report is used in the manufacture of sandpaper, scouring soaps, wood-finishing materials, etc., and does not include that used in the pottery and glass industries, and which is included in the report on flint and feldspar. On the other hand, the entire production of infusorial earth and tripoli is included in these statistics because the small production of these materials, although but little is actually used for abrasive purposes, does not justify separate treatment.

In treating these mineral products under the one subject of abrasives it is not always feasible to give detailed statistics regarding each, as would be done if they were treated separately, and proper comparisons between expenditures on account of the production of the different abrasives can not always be made, because some of the articles require more elaborate processes than others in their preparation for market. At none of the previous censuses have the abrasive materials been grouped as they are in this report. The statistics of mining operations for some of these minerals were reported for 1880 and 1889, but they were not brought together in a single class.

At the census of 1880 the classifications of abrasives were, corundum (emery), garnet, infusorial earth, oilstones, scythestones, and whetstones. At the Eleventh Census the classifications were, corundum, grindstones, infusorial earth, millstones, and whetstones.

In Table 1 are given the statistics for these several classifications for the censuses of 1902 and 1889, and while not comparable, yet they indicate in some measure the growth in the production of abrasive materials for this period. For corundum and emery, and also for oilstones, whetstones, and scythestones, comparisons of most of the items can be made for the two censuses.

Buhrstones and millstones to the value of $1,425, included in the statistics for 1902, were quarried at granite quarries; grindstones and pulpstones to the value of $403,066, and oilstones, whetstones, and scythestones to the value of $38,612 at sandstone quarries; and infusorial earth, tripoli, and pumice to the value of $1,436 at talc and soapstone mines, all as by-products. In these cases the wages and other expenses of production are included in the statistics for granite, sandstone, and talc and soapstone, respectively.

The production of certain of these abrasives is on the decline, while that of others is increasing, but because of the increase in manufacturing industries the aggregate amount of abrasive materials used in the United States is greater than ever before. As their use is limited there could easily be an overproduction of most of them, but in the aggregate there will be an increasing demand from year to year. This will depend principally upon the growth of our manufacturing industries and the development of our agricultural lands, and with an increase or a decrease in manufacturing especially there will be a corresponding change in the production of abrasives. The principal change, however, that will be noticed is in the amount of the different kinds of abrasives used from year to year, the production of some increasing rapidly, others steadily decreasing, these variations being due to the introduction of new natural or artificial abrasive products, to changes in methods of manufacturing, and to the use of new types of machinery, affecting principally the abrasives formerly used for agricultural implements.

TABLE 1.—COMPARATIVE SUMMARY: 1902 AND 1889.

	Year.	All abrasives.	Buhrstones and millstones.	Corundum and emery.	Crystalline quartz.	Garnet.	Grindstones and pulpstones.	Infusorial earth, tripoli, and pumice.	Oilstones, whetstones, and scythestones.
Number of mines or quarries	1902	82	29	5	6	7	9	11	15
	[1]1889								
Number of operators	1902	75	29	5	5	7	9	10	10
	[1]1889								
Salaried officials, clerks, etc.:									
Number	1902	[illegible]	7	[illegible]	8	12	25	8	6
	1889	(1)	(1)	(2)	(1)	(1)	(1)	(1)	(1)
Salaries	1902	$48,008	$1,682	[illegible]	$6,030	$9,178	$13,042	$4,016	$5,100
	1889	(1)	(1)	(2)	(1)	(1)	(1)	(1)	
Wage-earners:									
Average number	1902	610	[illegible]	47	20	[illegible]	210	25	[illegible]
	1889	550	[4][illegible]	[4]129	[illegible]	(1)	(1)	[4]52	[4]91
Wages	1902	[illegible]	[illegible]	[illegible]	$15,[illegible]	[illegible]	[illegible]	$13,[illegible]	$37,977
	1889	[illegible]	$17,6[illegible]	[illegible]	(1)	(1)	(1)	$8,[illegible]	$21,911
Contract work	1902								
	1889	$3,1[illegible]	[illegible]	$600	(1)	(1)	(1)	$[illegible]	$800
Miscellaneous expenses	1902	$4[illegible],110	$1,480	$2,770	$[illegible]	$4,[illegible]	$24,483	$2,263	$1,[illegible]
	1889	$10,347	$925	$2,[illegible]	(1)	(1)	(1)	$6,955	$255
Cost of supplies and materials	1902	[illegible]	$1,800	[illegible]	$950	$10,[illegible]	$31,349	$2,247	$7,662
	1889	$12,[illegible]	$1,[illegible]	[illegible]	(1)	(1)	(1)	$700	$858
Product:									
Quantity, short tons	1902		[illegible]	1,[illegible]	17,104	3,926	[illegible]	6,415	3,873
	1889			2,245	(1)	(1)		3,466	2,921
Value	1902	[6]$1,177,711	[illegible]	[illegible]	$43,185	$132,820	$667,[illegible]	$55,991	$113,9[illegible]
	1889	[illegible]	$55,2[illegible]	[illegible]	(1)	(1)	$170,787	$23,372	$32,980

[1] Not reported.
[2] Included in wage-earners and wages.
[3] Included with statistics for sandstone.
[4] Includes foremen, their salaries are included in wages.
[5] Number of pieces.
[6] The United States Geological survey reports $1,[illegible], which includes products finished elsewhere than at the quarry.

During the past fifteen years, many experiments and investigations have been made with a view of producing artificial abrasives that would be equal to or superior to the natural products. As a result of these experiments there are now four artificial abrasives on the market—carborundum, crushed steel, alundum (artificial corundum), and adamite. The value of the artificial abrasives produced and used in the United States during 1902 was over $300,000, and will illustrate the extent to which these artificial products are being utilized at the expense of natural products.

As shown by Table 1, of the 82 mines or quarries producing abrasive materials in 1902, 29 are credited to buhrstones and millstones, this being due not to the large production of this type of abrasive, but to the fact that there were a great many individual operators in the New York field producing a small number of buhrstones. Grindstones and pulpstones are credited with only 9 mines or quarries, although the value of their production is greater than the value of the combined production of all the other abrasives.

These 82 mines or quarries were worked by 75 operators, there being 39 individuals, 17 firms, and 19 incorporated companies. Twenty-three of the 39 individual operators were producers of buhrstones and millstones. The next largest number of individual operators were the 7 producing oilstones and whetstones.

There were 35 mines or quarries that have produced abrasive materials of some kind during the past few years from which no production was reported for 1902. These were distributed among 16 states, from Maine to California. Nineteen were owned by individuals, 11 by firms, and 5 by incorporated companies. The capital stock issued by the incorporated companies amounted to $258,000, all of which was reported for the corundum and emery industry. While some of these idle plants may have shut down permanently, others will probably be producers again in another year or two. Development work, without production, was reported by 1 corundum and emery mine.

Capital stock of incorporated companies.—No definite comparisons can be made of the statistics of the incorporated companies producing abrasives, for the reason that the corporations are not always confined simply to the production of an abrasive material. Thus, in the case of the grindstone industry, the companies producing the greater amount of this abrasive are also producers of building stone, which is their principal product, the manufacture of the grindstones being the smaller part of their business. The details of their capitalization are, therefore, given under sandstones in the report on "Stone."

In Table 2 are given the details of the capitalization of the 19 incorporated companies producing abrasives.

TABLE 2.—CAPITALIZATION OF INCORPORATED COMPANIES, BY KINDS OF ABRASIVES: 1902.

	All abrasives.	Corundum and emery.	Crystalline quartz.	Garnet.	Grindstones and pulpstones.	Infusorial earth, tripoli, and pumice.	Oilstones, whetstones, and scythestones.
Number of incorporated companies	19	4	2	3	5	3	2
Capital stock and bonds issued	$5,545,900	$2,365,800	$300,000	$2,412,000	$253,100	$130,000	$85,000
Capital stock							
Total authorized—							
Number of shares	371,551	333,000	15,000	18,620	2,531	1,300	1,100
Par value	$6,235,100	$3,600,000	$300,000	$1,862,000	$253,100	$130,000	$90,000
Total issued—							
Number of shares	305,309	266,858	15,000	18,620	2,531	1,300	1,000
Par value	$4,565,900	$1,935,800	$300,000	$1,862,000	$253,100	$130,000	$85,000
Dividends paid	$30,860	$10,860	$10,000			$10,000	
Common—							
Authorized—							
Number of shares	366,051	328,000	15,000	18,620	2,031	1,300	1,100
Par value	$5,685,100	$3,100,000	$300,000	$1,862,000	$203,100	$130,000	$90,000
Issued—							
Number of shares	302,749	264,798	15,000	18,620	2,031	1,300	1,000
Par value	$4,309,900	$1,729,800	$300,000	$1,862,000	$203,100	$130,000	$85,000
Dividends paid	$20,000		$10,000			$10,000	
Preferred—							
Authorized—							
Number of shares	5,500	5,000			500		
Par value	$550,000	$500,000			$50,000		
Issued—							
Number of shares	2,560	2,060			500		
Par value	$256,000	$206,000			$50,000		
Dividends paid	$10,860	$10,860					
Bonds							
Authorized—							
Number	1,140	540		600			
Par value	$1,070,000	$470,000		$600,000			
Issued—							
Number	1,050	500		550			
Par value	$980,000	$430,000		$550,000			
Interest paid	$24,000	$24,000					

The total par value of the capital stock and bonds issued by the incorporated companies was $5,545,900. The tendency toward incorporation is most evident in the companies mining garnet and corundum and emery, but the capitalization reported for these companies includes also, in part, the amount utilized for the subsequent manufacturing process. These industries, too, are the only ones reporting a bonded indebtedness. Four companies producing corundum and emery reported a capital stock and funded debt amounting to $2,365,800, and three companies producing garnet reported $2,412,000 for the same items. No incorporated companies were reported as engaged in producing buhrstones and millstones.

Crystalline quartz; grindstones and pulpstones; infusorial earth, tripoli, and pumice; and oilstones, whetstones, and scythestones show a comparatively small average capitalization. Dividends amounting to $10,000 were paid on the common stock of crystalline quartz companies, and a like amount on the common stock of companies producing infusorial earth, tripoli, and pumice. Companies producing corundum and emery paid the sum of $10,860 as dividends on preferred stock, and $24,000 as interest on bonds having a par value of $430,000.

Employees and wages.—The total average number of employees engaged in the abrasive industry during 1902 was 685, of whom 75, or 10.9 per cent, were salaried employees, and 610, or 89.1 per cent, wage-earners. These received in salaries and wages $344,922, of which $48,008 was received by the salaried employees and $296,914 by the wage-earners. The classification of these salaried employees and wage-earners is shown in Tables 4 and 5.

Of the 610 wage-earners, only 25, or 4.1 per cent, were employed below ground, and of this number 22 were employed in the corundum and emery industry. The other 3 wage-earners below ground were engaged in the infusorial earth industry. All the other abrasives are obtained by means of open cuts and pits. Because of this the operations are of necessity somewhat curtailed during the winter months. As is seen in Table 4, the monthly average number of wage-earners employed during January, February, and March ranged from 429 to 478, while during the remaining months of the year the range was from 596 to 703. The daily rates of pay of the wage-earners, also shown in Table 4, varied from 75 cents to $4.24, the lowest wages being paid principally to the miners or quarrymen and the highest to the engineers and machinists.

Of all the wage-earners, 212, or 34.8 per cent, received from $1.50 to $1.74 per day, and of these, 160, or 75.5 per cent, were miners or quarrymen. Twenty-six per cent of the wage-earners received less than $1.50 per day. Of the total number 6.5 per cent were classified as engineers, of whom the greater number received from $2 to $2.24 per day; 402, or 65.9 per cent, were returned as miners, their wages varying from 75 cents to $3.24 per day. Only 10 miners' helpers were reported, but it is very probable that the actual number of this class of wage-earners was considerably in excess of this figure, since many of them were included under "all other wage-earners." It will be noticed that in this industry the question of child labor is unimportant, as only 3 boys under 16 years were employed.

Supplies, materials, and miscellaneous expenses.—The total cost of the supplies and materials used in the mining and quarrying of the abrasive materials produced in 1902 was $80,309. Of this amount, $31,349, or 39 per cent, was used in the grindstone industry, and $26,114, or 32.5 per cent, in the corundum and emery industry.

The miscellaneous expenses amounted to $42,410, of which $8,421 was paid out for royalties and rent of mine and mining plant, and $33,989 for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—Of the primary power reported, 2,300 horsepower, or 92.2 per cent, was steampower applied by 71 steam engines. Forty-one steam engines, having a total of 1,235 horsepower, were used in the grindstone and pulpstone industry. The next largest number of steam engines, 13, was reported for the oilstone, whetstone, and scythestone industry, but these aggregated only 185 horsepower, while the 7 steam engines used in the garnet industry aggregated 420 horsepower, and the 7 in the infusorial earth, tripoli, and pumice industry had a total of 410 horsepower. Eighty-eight horsepower was generated by 7 gas or gasoline engines, of which 3, having a capacity of 80 horsepower, were used in the corundum and emery industry, and 4, having 8 horsepower, in the oilstone, whetstone, and scythestone industry. In addition there was 1 electric motor, having a capacity of 5 horsepower; this was used in the infusorial earth, tripoli, and pumice industry.

Production.—The value of the production was $1,177,711, an increase of $541,052 over the value reported for 1889, which was $636,659. Of the particular abrasives, grindstones and pulpstones show the largest increase, $227,844 in value, over the production of 1889. The second largest increase was in oilstones, whetstones, and scythestones, the value of which was $113,968 in 1902, an increase of $80,988.

Oilstones and whetstones are not always finished at the quarries, but are in some instances shipped to a central plant and there prepared for use. When the finishing process is not conducted immediately in connection with the actual quarrying, the value of the crude product is given in Census reports. In the reports of the United States Geological Survey, on the other hand, the finished value is given, for the reason that, with the exception of Arkansas novaculite, this material would not be marketable in its crude state. Were the finished value to be taken in every instance by the Bureau of the Census, the total product for oilstones, whetstones, and scythestones would be increased by $107,794, and the production would rank as second instead of third among abrasive materials.

In order to show comparatively the value of the annual consumption of each abrasive used in the United States, the value of the domestic product and of the imports reported since 1880 are given in the following table. The statistics are compiled from tables of the United States Geological Survey published in "Mineral Resources of the United States."

TABLE 3.—ABRASIVE MATERIALS—VALUE OF DOMESTIC PRODUCTS AND IMPORTS, BY KINDS: 1880 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.[1]	ALL ABRASIVES.		BUHRSTONES AND MILLSTONES.		CORUNDUM AND EMERY.		CRYSTALLINE QUARTZ.[2]	GARNET.[2]	GRINDSTONES AND PULPSTONES.		INFUSORIAL EARTH, TRIPOLI, AND PUMICE.		OILSTONES, WHETSTONES, AND SCYTHESTONES.	
	Value of domestic product.	Value of imports.	Value of domestic product.	Value of imports.	Value of domestic product.	Value of imports.	Value of domestic product.	Value of domestic product.	Value of domestic product.	Value of imports.	Value of domestic product.[3]	Value of imports.[4]	Value of domestic product.	Value of imports.
1880	$782,880	$321,425	$200,000	$125,072	$29,280	$108,894	....	....	$500,000	$76,274	$45,600	....	[5] $8,000	$11,185
1881	748,500	305,103	150,000	103,912	80,000	97,432	....	....	500,000	87,128	10,000	....	8,500	16,631
1882	998,000	327,846	200,000	104,034	80,000	98,695	....	....	700,000	97,225	8,000	....	10,000	27,892
1883	865,000	295,213	150,000	73,685	100,000	85,498	....	....	600,000	105,852	5,000	....	10,000	30,178
1884	845,000	307,799	150,000	46,100	108,000	148,900	....	....	570,000	86,286	5,000	....	12,000	26,513
1885	728,000	182,290	100,000	35,477	108,000	74,800	....	....	500,000	50,579	5,000	....	15,000	21,434
1886	527,190	211,863	140,000	29,935	116,190	121,638	....	....	250,000	39,149	6,000	....	15,000	21,141
1887	463,400	166,681	100,000	24,007	108,000	68,269	....	....	224,400	50,312	15,000	....	16,000	24,093
1888	479,920	237,905	81,000	37,228	91,620	118,216	....	....	281,800	51,755	7,500	....	18,000	30,676
1889	636,661	344,970	35,155	40,884	105,567	219,966	....	....	439,587	56,720	23,372	....	[5] 32,980	27,400
1890	683,264	239,841	23,720	33,905	89,395	123,367	....	....	450,000	45,115	50,240	....	69,909	37,454
1891	754,918	151,713	16,587	24,089	90,230	71,282	....	....	476,113	21,028	21,988	....	150,000	35,314
1892	667,346	249,281	23,417	34,186	181,300	120,023	....	....	272,244	61,082	43,655	....	146,730	33,120
1893	655,516	242,898	16,639	30,261	142,325	127,767	....	....	338,787	59,569	22,592	....	135,173	25,301
1894	590,342	169,419	13,887	18,087	95,936	71,273	$18,054	$90,660	223,214	52,088	11,718	....	136,873	26,671
1895	633,011	240,069	22,542	20,416	106,256	133,038	27,000	95,050	205,768	51,276	20,514	....	156,881	32,139
1896	703,406	291,979	22,567	26,965	113,246	118,231	18,000	68,877	326,826	66,195	26,792	....	127,098	50,588
1897	776,272	237,468	25,932	22,956	106,574	130,531	22,500	80,853	368,058	49,496	22,385	....	149,970	34,485
1898	1,098,784	251,227	25,934	23,999	275,064	133,399	23,990	86,850	489,769	62,973	16,691	....	180,486	30,856
1899	1,225,211	274,374	28,115	18,881	150,600	137,131	39,000	98,325	675,586	63,852	25,302	....	208,283	54,510
1900	1,208,073	400,307	32,858	28,901	102,715	239,506	40,705	123,475	710,026	92,581	24,207	....	174,087	39,319
1901	1,194,772	490,712	57,179	12,187	146,040	294,929	41,500	158,100	580,703	88,871	52,950	....	158,300	61,665
1902	[6] 1,326,755	426,738	59,808	16,158	104,605	214,842	84,435	132,820	667,431	76,908	55,994	$62,374	221,762	56,456

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[1] The value of imports is for fiscal years up to 1886, subsequent years are calendar years.
[2] Figures for imports and figures for domestic product prior to 1894, not available.
[3] Prior to 1902 no value for pumice is included in these figures.
[4] Figures not available except for 1902.
[5] Value of unfinished product was reported for 1880 and 1889.
[6] Including $107,794 for finished oilstones, whetstones, and scythestones, and $41,250 the value of quartz, ground, not shown in Census tables.

The value of imports of all abrasives for 1902, $426,736, is 32.2 per cent of the value of the domestic production. The combined value of the domestic production and imports for 1902 was $1,753,491, which is greater than the combined value reported for any other year. In many cases the market value of abrasives is less at the present time than it was ten or twenty years ago, so that the values given represent a greater tonnage now than then.

Of the total value of the imports in 1902, $214,842, or 50.3 per cent, was for corundum and emery, the domestic production of this abrasive being a little less than one-half this value, or only $104,605. The year in which the combined value of the domestic production and imports of corundum and emery was greatest was 1901, when it amounted to $441,039. In that year the value of these imports was greater than during any other year on record, being $294,999, or $80,157 more than in 1902. The year when the value of the domestic production was greatest was 1898, when it amounted to $275,064. The value of the domestic production in 1902, $104,605, was less than that of thirteen of the years recorded. The selling price of corundum and emery varies from 1 to 10 cents per pound.

The class of abrasives ranking next in value of imports is grindstones and pulpstones, for which the imports in 1902 amounted to $76,906, or 18 per cent of the total value of all imports. This is, however, only 11.5 per cent of the total value of the domestic production of grindstones, which was $667,431. A large proportion of the value reported for the imports of grindstones was for pulpstones, from Newcastle-upon-Tyne, England, which are considered to be superior in some respects to those made from the Ohio sandstone. The American stone, however, is giving good satisfaction, which should ultimately cause a decrease in the imports of these pulpstones. The combined value of the imports and domestic production of grindstones and pulpstones was greatest in 1900, when it amounted to $802,607, being $58,270 more than the combined value for 1902, $744,337. The value of the domestic production was greatest in 1900, when it amounted to $710,026, which is $42,595 more than the value of the 1902 production. The next highest value, $700,000, was reached in 1882. It must, however, be taken into consideration that the tonnage of the production during the past ten years was much greater than in 1882, for in that year grindstones were worth about $15 per ton, while now they are sold at from $8 to $10 per ton.

The value of the domestic production of buhrstones and millstones in 1902, $59,808, was greater than that for any year since 1888; while the value of the imports, $16,158, was less than for any year recorded. The combined value of the imports and domestic production in 1902 was $75,966, which is $249,106 less than that of the year of greatest value, 1880, when the figures were $325,072. In that year the value of the imports was also greatest, amounting to $125,072, and the value of the domestic production, $200,000, was only equaled by one other year, 1882. This enormous decrease in the value of buhrstones used in the United States is due largely to the introduction of the roller mill process for grinding wheat. The increase in the domestic production since 1889 is due to the utilization of buhrstones in grinding the coarser cereals, mineral paints, etc., and, as the American stone answers as well for this purpose as the foreign, the continued falling off in the value of the imports is thus partially accounted for.

The combined value of the imports and domestic production of infusorial earth, tripoli, and pumice in 1902 was $118,368, of which $62,374, or over one-half, was the value of the imports. The value of the pumice imported was eight times the value of that produced in this country, while the value of the imports of infusorial earth was only three-fourths the value of the domestic production. It will be noticed that the domestic production of infusorial earth varies very widely from year to year, this being due to its limited use and also to the fact that some producers will mine in one year a quantity sufficient to last them two or more years. The small production of domestic pumice compared to the quantity imported is due to the distance of the domestic deposits from the large markets, which makes it impossible to compete with the pumice imported from the island of Lipari, Italy.

For oilstones, whetstones, and scythestones the combined value of the domestic production and imports for 1902, $278,218, was greater than that for any year since these statistics have been collected. The value of the domestic production for 1902, $221,762, was greater than that of any other year recorded, and was nearly four times the value of the imports for that year of $56,456. The year in which the value of imports was greatest was 1901, when it was $64,655, this being $8,199 more than the value of the imports of 1902. The almost constant increase in the oilstone industry is well illustrated in Table 3. The value of the domestic production has increased from $150,000 in 1891 to $221,762 in 1902. In the same time the imports have increased from $35,344 to $56,456. Prior to 1891 the statistics of the value of the domestic production represented the value of rough, crude rock, while since then it has been principally for the finished oilstone.

There have been no imports recorded of garnet or of crystalline quartz, but in the value of the domestic production of each there has been a general increase. The year of largest production of garnet was in 1901, when the product was valued at $158,100, this being $25,280 more than the value of the production of 1902, $132,820, which was the next highest value recorded. The increase in the value of crystalline quartz used for abrasive purposes has been very marked, and, with the exception of 1896, the value each year has been greater than that of the year before.

The state in which the greatest value of abrasive materials was produced during 1902 is Ohio, the value being $587,284. The abrasive was principally grindstones, the value of which was $560,412, the balance being oilstones and whetstones. New York was second, with a value of $189,345, the abrasives produced in their order of production being garnet, emery, buhrstones, crystalline quartz, and tripoli.

The detailed statistics of abrasive materials for 1902 are given by states in Table 4 and by classes in Table 5.

DESCRIPTIVE.

The natural abrasive materials can readily be divided into two general groups:

1. Those which occur as rock formation and are cut and manufactured directly into the form desired, while retaining their original rock structure and appearance, as grindstones and whetstones.

2. Those which occur as a constituent of either a rock or a vein, and have to be mechanically separated from the associated gangue and cleaned, as corundum, emery, and garnet.

The artificial products would make a third class of abrasive materials, including carborundum, crushed steel, etc.

The abrasive materials are so universally distributed that there are but few localities where some of them may not be found. While this is the case, various kinds of abrasives are constantly being exported from and imported into the different countries on account either of their superior abrasive efficiency or of their better adaptability to required purposes.

The use of any particular abrasive is dependent upon the character of the abrasion to be accomplished. Thus, while the efficiency of a certain abrasive, as an abrasive, may be greater than that of another, it will not do as satisfactory work as one with less abrasive efficiency. For instance, although corundum has the highest abrasive efficiency of any included in the second type of abrasives mentioned, there are a number of cases where garnet, with a much lower abrasive efficiency, will give better satisfaction.

Grindstones.—The abrasive that is perhaps the most familiar to all is the grindstone. This is produced at the present time in commercial quantities in Michigan, Ohio, and West Virginia, and in much smaller quantities in Montana and Wyoming. The largest quantities are quarried in Ohio, whence the product is shipped to all parts of the United States. The quarries in the northern part of Ohio are located at Chagrin Falls, Berea, Cuyahoga Falls, Elyria, Euclid, Grafton, Independence, Massillon, North Amherst, Oberlin, and Peninsula; those in the eastern part of the state at Empire, Freeport, and Tippecanoe; and those in the southern portion of the state at Amesville, Belpre, Briggsdale, Constitution, Federal, Gravel Bank, Portsmouth, Vincent, and Marietta. A large number of the quarries in northern and southern Ohio have been brought under one management. At Empire, Peninsula, and Tippecanoe the pulpstone variety of grindstone is found; at the quarries at Empire pulpstone is the chief production, the regular grindstone forming but a very small part of the output.

In Michigan there was but one locality in 1902 producing grindstones—that near Grindstone City—but the state ranked next to Ohio in the value of its product.

The quarries in West Virginia are directly across the Ohio river from those in southern Ohio, and are located at Atlantic, Bois, Briscoe, Lonecedar, and Sherman.

Grindstones in very small quantity have been made for local use near Columbus, Yellowstone county, Mont.; near Rawlins, Carbon county, Wyo.; and near Edgemont, S. Dak.; but from the latter locality there was no production in 1902.

There is considerable variation in grindstones, dependent upon the variation of the sandstone from which they are made, which is due (1) to the character of the cementing material—whether it is a hydrous iron oxide, calcium carbonate, or silica; (2) to the percentage of the cementing material—that is, whether the grains are separated from each other by simply a minute film of cementing material or by a considerable layer; (3) to the size and shape of the grains of quartz. According to these variations, there are at least seven grits that are recognized as distinctive, six of which are derived from various grades of Ohio sandstone and one from the Michigan stone. These grits are as follows:

1. The Berea grit, which is a fine, sharp grit, used especially for sharpening edge tools, such as farmers' tools and woodworkers' small tools.

2. The Amherst grit, which is soft and loose, medium and loose, and fine. It is used especially for edge tools, saws, etc., in manufacturing establishments where the grindstone is propelled by steam.

3. The Independence grit, which is a coarse, sharp grit, is used for grinding springs and files and for the dry grinding of castings.

4. The Massillon grit, a coarse, sharp grit, used for grinding large edge tools, springs, files, and castings.

5. The Tippecanoe grit, which is a fairly loose, hard grit, used for grinding wood pulp, springs, files, and heavy forgings.

6. The Marietta grit, which is soft and loose, is used largely in grinding saws, machine knives, and other highly tempered, thin steel tools.

7. The Huron (Michigan) grit is a fine, sharp grit, used for cutlery, mowing machine sections, and tools of that character, where a fine edge is required.

An eighth might be added—the Peninsula grit—a hard and coarse grit, used for grinding wood pulp. In addition to these grades of stone, a grit known as Euclid stone, which contains about 70 per cent of fine silica and 30 per cent of clay, is used for whetters, principally in cutlery works, for polishing out the scratches made by the ordinary grindstone. The production is small, but important.

It may be well to mention here the grades of grindstones that are imported into the United States, as they are used for special purposes for which they seem to be particularly adapted. A grindstone made from a coarse, hard sandstone is imported from Bavaria, and is used particularly for razor grinding. A fine, hard grindstone, called the Craigleith, is imported from Edinburgh, and is used for special purposes in the glass trade.

Although sandstone suitable for the manufacture of grindstones is not uncommon, the variety adapted to the manufacture of a pulpstone is somewhat rare. A considerable demand for pulpstones rose when paper began to be manufactured from wood pulp. In this manufacture a stone is required that can be run in hot water. The Peninsula grit obtained from Peninsula, Tippecanoe, and Empire, Ohio, if carefully selected, ought to make a good pulpstone, which should easily compete with that imported from Newcastle-upon-Tyne, England.

The natural grindstone manufactured from sandstone was formerly in universal use in all kinds of manufacturing plants and in the household, but there has been introduced successfully during the past ten years a grindstone made from emery or corundum. While at the present time only the smaller sized grindstones for household use are made of these materials, it is possible that in the near future large wheels will be made that will rival some of the larger grindstones.

Oilstones, whetstones, and scythestones.—The terms oilstone, whetstone, and scythestone are used somewhat ambiguously, and often the same stone when used for one purpose will be called an oilstone, and when used for another purpose a whetstone, or even a scythestone. The term oilstone has come to be applied to all stones used for sharpening mechanics' tools, for the reason that it is necessary to use oil on most of them to prevent the stone from becoming hot and thus heating the tool, and also to prevent the small particles of steel that are ground off the tools from entering into the pores of the stone.

A considerable change from one census to another is noticeable in the oilstone, whetstone, and scythestone industry in respect to the stone that has the greatest use. While the sale of oilstones and whetstones has increased, or at least held its own, in the United States since 1889, there has been a considerable falling off in the sale of scythestones. This is undoubtedly due to the small number of scythes, sickles, etc., used at the present time, these having been largely replaced by improved agricultural machines and implements. Scythestones are now used in quantity only in those states or countries into which the improved agricultural machines have not yet been introduced. Thus, while the production of scythestones in the United States has remained about the same, it has become necessary to seek a market for them in foreign countries, and a considerable proportion of the production is exported.

The whetstone producing rocks are all sedimentary in origin, and include quartz-mica-schist, sandstone, novaculite, and intermediate rocks. These are found abundantly in various localities, so that there are probably but few countries which have not within their borders a supply of some kind of stone suitable for making whetstones. Although the material for manufacturing whetstones is so common, only those quarries which produce stones of superior quality and have the greatest advantages for manufacturing and shipping can survive the competition in the trade. This is of course the reason the production of whetstones is confined to a few localities. Occasionally a stone is found of exceptional quality, as the novaculite of Arkansas, for which there is a large demand, although the price may be much higher than that of other whetstones. At the present time the domestic supply of whetstones is obtained from Arkansas, Indiana, Ohio, New Hampshire, and Vermont. There is undoubtedly considerable whetstone material utilized in other states, but those mentioned are the only ones that have produced this abrasive for the market.

At the whetstone quarries in Arkansas, which are in Garland and Saline counties, principally at and in the vicinity of Quarry or Whetstone mountain, Garland county, there is obtained the novaculite (sandstone) from which is manufactured the best and most valuable natural oilstone or whetstone on the market. The quality of the rock varies greatly, even in different parts of the same quarry, but two distinct types of stone or grit are recognized, which are known on the market as the Arkansas and Washita. The latter is less dense and much more porous than the Arkansas. Both of these types are divided into two grades, known as soft and hard. They are used principally in the form of small wheels, oilstones of different shapes, and points such as are used by engravers, surgeons, carvers, dentists, jewelers, watchmakers, and diesinkers.

The sandstone of Orange county, Ind., furnishes a whetstone known as the Hindostan or Orange stone, which is quarried in French Lick and Northwest townships. The stone is fine grained and is used for oilstones. It is considered the best low priced sharpening stone for mechanics' tools. A considerable quantity of this stone is now being exported.

At a number of the sandstone quarries in Ohio from which grindstones are obtained, principally at Berea, in Cuyahoga county, and at Grafton, in Lorain county, a grade of stone is found suitable for whetstones. This stone makes a scythestone that does good work, but it does not stand transportation so well as the scythestone made from schist. At Euclid, Cuyahoga county, is a fine grained sandstone from which a considerable number of oilstones are made. The well-known Deerlick oilstone is made at Chagrin Falls, in the same county, from a fine grained sandstone. Since the introduction of this stone a few years ago its production has increased considerably each year.

In Cortland county, N. Y., near Labrador Lake, a sandstone similar to that quarried in Ohio is found. It is known as Labrador stone, and is used to a limited extent in the manufacture of whetstones, although no product was reported as quarried in 1902.

In Haverhill, Grafton county, N. H., and near Lamoille, Orleans county, Vt., there is a quartz-mica-schist from which are manufactured the celebrated Indian Pond, White Mountain, and Lamoille scythestones. These schists are variable in their structure, so that only portions or bands of them can be utilized. The cutting quality of the stones varies with the compactness of the schists and the percentage of quartz or grit contained. There are two principal grades of stone found at the New Hampshire quarries, which are known as the Indian Pond and the White Mountain. Both of these stones come from the same quarry. The White Mountain is more compact and has a finer texture, and the Indian Pond includes the more laminated varieties of the schist. The name Indian Pond was used as early as 1820 for a stone obtained from a stratum of schist about 7 miles south of Pike Station, near a pond known by the above name. The stones from the quarries at Lamoille are sold under the name of Lamoille stones. At Lisbon, Grafton county, N. H., there occurs a fine grained quartz-mica-schist of a bluish chocolate color, which furnishes a stone known as the chocolate whetstone. It is a medium hard stone and is especially adapted for leather and skinning knives, and it is also used extensively for sharpening cloth cutters' tools, kitchen and carving knives, etc.

Buhrstones and millstones.—The American buhrstone and millstone varies from a sandstone to a quartz conglomerate, which occurs along the eastern slope of the Appalachian mountains, from North Carolina to New York, and is known by different names, according to the locality from which it is obtained. Occasionally a granite is also used in the manufacture of this stone. The states producing buhrstones and millstones in 1902 were New York, North Carolina, Pennsylvania, Vermont, and Virginia, by far the larger production coming from New York. The buhrstone produced in New York is principally from Ulster county, and is known as Esopus stone. The Pennsylvania stones, which are obtained in Lancaster county, are known as Turkey Hill and Cocalico. From Montgomery county, Va., is obtained a buhrstone which is known on the market as Brush mountain stone. In Rowan county, N. C., a granite is quarried and manufactured into millstones, which are sold, for the most part, in North Carolina and Georgia.

Whereas formerly a large number of buhrstones were used in the United States, principally in grinding wheat, now very few are used for that purpose on account of the introduction of the roller mill process. Buhrstones are still used for this purpose only in certain mountain districts where railroad facilities are wanting. New uses, however, have arisen for these stones, and they are now employed quite extensively for grinding the coarser cereals, mineral paint ores, fertilizers, cement rock, barytes, and other minerals. For these purposes the use is increasing each year, although at the census of 1902 the value of the buhrstones produced was only about one-sixth of the value of those reported at the census of 1880. The decided change in this industry began in 1888, and there was a gradual falling off until 1894, when the industry again began to improve with the introduction of the new uses for the stone.

Garnet.—The greater part of the garnet that is mined for abrasive purposes, except the production from North Carolina, is used in the manufacture of garnet paper, which is extensively employed for abrasive purposes in the manufacture of boots and shoes. Nearly all the production from North Carolina is manufactured into wheels, which are sold as emery wheels. The abrasive value of garnet was known to the North American Indians, who engraved shells with tools consisting of garnet points attached to wooden handles.[1]

During 1902 garnet was obtained from Connecticut, New York, North Carolina, and Pennsylvania.

In Connecticut, near Roxbury, Litchfield county, garnet is obtained from a mica-schist, in which it occurs in crystals from less than a quarter of an inch to nearly two inches in diameter. As the rock is crushed, the crystals readily separate from the schist, making a clean garnet concentrate, that is ready for crushing and sizing.

The principal New York garnet localities are near North river, in Warren county, and in Essex county. The mineral occurs in segregated masses, in both gneiss and limestone rocks, varying in size from that of a pigeon's egg to a diameter of 20 feet. Commercially, this garnet is designated (1) as massive garnet, when it is in the larger masses, which are impure; (2) as shell garnet, which is nearly pure garnet; and (3) pocket garnet, when it occurs in small masses or crystals in the gneiss. Of these, the shell garnet is considered the most valuable.

The North Carolina garnet deposits that have been developed are all in Jackson county. The principal mine is on Sugar Loaf mountain, about one and one-half miles from the railroad. The occurrences are all similar, being bands of garnetiferous gneiss in ordinary gneiss. These bands are 50 or more feet in width, and average from 15 to 30 per cent of garnet.

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[1] United States Geological Survey, Twelfth Annual Report, Part VI, 1889, page 608.

In Delaware and Chester counties, Pa., a garnet occurs in small crystals and fragments thickly disseminated through a gneiss which is badly decomposed. A considerable product, reported from Delaware county, is known on the market as rose garnet.

Crystalline quartz.—The production of crystalline quartz that is included under the head of abrasives, is that which is used in the manufacture of sandpaper, scouring soaps, and as a wood finisher. In addition to these uses there are large quantities of quartz sand used in the stonecutting trade, especially by the marble workers. A small amount of quartz is pulverized, and sold under the name of tripoli. Of the production reported for 1902 the larger amount was used as a wood finisher, and was obtained from Connecticut. Most of that used in the manufacture of sandpaper was mined in Pennsylvania.

Infusorial earth and tripoli.—Among the abrasives, infusorial earth and tripoli formed but a small proportion of the production, and of the amount produced less than half was actually used for abrasive purposes. Under the head of infusorial earth and tripoli are included all porous, siliceous earths of organic origin, such as infusorial earth, diatomaceous earth and tripoli, and also a siliceous material which is the residue from an impure siliceous limestone by the leaching out of the calcium carbonate. The material produced in 1902 was from California, Georgia, Maryland, Missouri, New Hampshire, New York, and Virginia.

Pumice.—The production of pumice in the United States has been very erratic during the time for which statistics of this material have been published, although commercial deposits are known to occur in large quantity, especially in Utah and Nebraska. On account, however, of the distance of these deposits from the railroad, and from the large markets, they are not able to compete with the pumice imported from Lipari, Italy, which is shipped largely as ballast, and which, after being ground and bolted, is sold in New York at from 2 to 2½ cents per pound. These Lipari deposits supply almost the entire demand for pumice. During 1902 the entire production of pumice in the United States was from the Nebraska deposits, and was used largely in the manufacture of soaps and scouring powders.

Corundum and emery.—The natural abrasives that have the highest abrasive efficiency are corundum and emery, and there is an increasing demand for these, which is due largely to the increase in manufacturing, especially of agricultural machines, but also to the improved methods that have been devised for making emery and corundum stones and wheels of all shapes and sizes. These abrasives, manufactured into wheels of various sizes, have replaced, to some extent, the smaller grindstones in manufacturing establishments. They have also been manufactured into oilstones and whetstones, and have successfully competed with the natural product, although selling at a higher price. With the exception of certain emery wheels made by the silicate process, and used for saw gummers, no large emery wheels have as yet been made. Even if large vitrified emery wheels could be made, it is a question whether their cost could be lowered sufficiently to permit them to enter into competition with the grindstone, and also whether the emery stone would do as satisfactory work as the grindstone for certain kinds of grinding.

Of the corundum and emery used in the United States about one-half is produced in this country, the remainder being obtained from the Turkish and Grecian emery mines, and from the Canadian corundum mines. There were but a few tons of corundum produced in the United States in 1902, the production of this type of abrasives being almost entirely of the emery variety. Corundum was formerly regarded as occurring sparingly in nature, but it is now known to have a rather wide occurrence and to exist in commercial quantity in many localities. With the known occurrences of this mineral in this country there should be no difficulty in such production of it as to fully satisfy the markets' demand. Competition with the Canadian corundum will be strong, and if there is a decrease in price, the location of the deposits for easy mining and sufficient railroad facilities will need to be very favorable if they are to be profitably worked. The value of corundum in 1902 was from 7 to 10 cents per pound when cleaned and sized. Emeries varied in price from 1 to 5 cents per pound.

The more promising deposits of corundum in the United States are as follows: In North Carolina, at Corundum Hill, Macon county; at Sapphire, Jackson county; and at Brick creek, Clay county. In Georgia, at Laurel creek, Rabun county; and in Montana, on the headwaters of Elk creek, Gallatin county. The emery deposits are near Peekskill, N. Y., and at Chester, Mass., the latter furnishing the most of the emery produced in the United States. During 1902 there was also a small production in Montana.

TABLE 4.—DETAILED SUMMARY, BY STATES, 1902.

	United States.	Arkansas.	Connecticut.	Indiana.	New York.	Ohio.	Pennsylvania.	Virginia.	All other states.[1]
Number of mines or quarries	82	4	6	6	30	8	5	5	18
Number of operators	75	3	5	5	30	8	5	5	14
Character of ownership:									
Individual	39	2	2	4	22	1	4	1	3
Firm	17		2	1	4	3		3	4
Incorporated company	19	1	1		4	4	1	1	7
Salaried officials, clerks, etc.:									
Total number	75	2	9		17	25	1	3	18
Total salaries	$48,008	$1,050	$6,318		$12,139	$13,192	$840	$1,942	$12,527
General officers—									
Number	[illegible]		2		[illegible]	[illegible]		2	2
Salaries	$13,161		$2,000		$3,300	$2,880		$1,471	$3,450
Superintendents, managers, foremen, surveyors, etc.—									
Number	43	2	5		10	15	1	1	9
Salaries	$25,896	$1,050	$3,118		$7,339	$7,882	$840	$471	$4,806
Foremen below ground:									
Number	1								1
Salaries	$600								$600
Clerks—									
Number	18		2		3	5			6
Salaries	$8,801		$1,200		$1,440	$2,430			$3,671
Wage-earners:									
Aggregate average number	640	23	20	24	135	149	20	21	201
Aggregate wages	$296,914	$10,615	$9,521	$9,063	$81,710	$69,336	$8,226	$8,273	$100,170
Above ground—									
Total average number	585	23	19	24	134	149	20	18	179
Total wages	$280,416	$10,615	$9,521	$9,063	$81,140	$69,336	$8,226	$7,025	$85,170
Engineers, firemen, and other mechanics—									
Average number	75	1	1		6	27	2		35
Wages	$49,777	$600	$600		$8,121	$15,313	$840		$27,295
Miners or quarrymen, and stonecutters—									
Average number	387	22	18	23	124	88	**15**	18	79
Wages	$170,778	$10,015	$8,321	$8,688	$52,623	$40,305	$6,786	$7,025	$42,145
Boys under 16 years—									
Average number	3			1		2			
Wages	$912			$375		$537			
All other wage-earners—									
Average number	120				41	32	2		45
Wages	$58,954				$20,219	$13,181	$600		$21,840
Below ground—									
Total average number	57				1			2	52
Total wages	$16,498				$570			$1,248	$14,680
Miners—									
Average number	15				1			2	12
Wages	$10,548				$570			$1,248	$8,730
Miners' helpers—									
Average number	**10**								10
Wages	$5,850								$5,850
Average number of wage-earners at specified daily rates of pay:									
Engineers—									
$1.25 to $1.49	1								1
$1.50 to $1.74	6	1			1		2		2
$1.75 to $1.99	1				1				
$2.00 to $2.24	22		1			1			17
$2.25 to $2.49	3				1	1			1
$2.50 to $2.74	2								2
$3.00 to $3.24	1					1			
$3.50 to $3.74	1								1
Firemen—									
$1.00 to $1.24	1								1
$1.75 to $1.99	14					3			11
Machinists, blacksmiths, carpenters, and other mechanics—									
$0.75 to $0.99	1								1
$1.50 to $1.74	3				2	1			
$1.75 to $1.99	7				1	6			
$2.00 to $2.24	7				3	3			1
$2.25 to $2.49	1								1
$3.00 to $3.24	1								1
Miners or quarrymen, and stonecutters—									
$0.75 to $0.99	13								13
$1.00 to $1.24	38			10	1	7		4	16
$1.25 to $1.49	66			3	3	34		11	15
$1.50 to $1.74	160	22	12	10	43	32	14	3	24
$1.75 to $1.99	70		5		33	3			29
$2.00 to $2.24	35		1		24	3	1	2	4
$2.25 to $2.49	4					3			1
$2.50 to $2.74	7					6			1
$2.75 to $2.99	3				2				
$3.00 to $3.24	8								8
Miners' helpers—									
$1.50 to $1.74	5								5
$1.75 to $1.99	5								5
Boys under 16 years—									
$0.75 to $0.99	2					2			
$1.25 to $1.49	1			1					
All other wage-earners—									
$0.75 to $0.99	6								6
$1.00 to $1.24	11					2	2		7
$1.25 to $1.49	16				1	13			2
$1.50 to $1.74	35					17			18
$1.75 to $1.99	21				20				1
$2.00 to $2.24	20				20				
$2.50 to $2.74	3								3
$3.00 to $3.24	2								2

[1] Includes operators distributed as follows: California, 1; Georgia (operator included under talc and soapstone), Kentucky, 1; Maryland, 1; Massachusetts, 2; Michigan (operator included under sandstones and quartzites); Missouri, 2; Montana, 1; Nebraska, 1 (2 quarries); New Hampshire, 1 (3 quarries); North Carolina, 1; Vermont, 1 (2 quarries); West Virginia, 2; and Wyoming (operator included under sandstones and quartzites).

TABLE 4.—DETAILED SUMMARY, BY STATES: 1902—Continued.

	United States.	Arkansas.	Connecticut.	Indiana.	New York.	Ohio.	Pennsylvania.	Virginia.	All other states.
Average number of wage earners employed during each month:									
Men 16 years and over—									
January	457	16	6	18	94	126	9	20	168
February	437	16	6	21	97	119	9	20	149
March	475	25	8	20	106	142	9	21	173
April	605	26	21	20	166	136	22	23	191
May	660	27	22	20	172	138	22	28	231
June	675	27	17	20	166	172	22	22	229
July	675	27	17	20	166	150	22	19	254
August	740	27	33	20	163	171	22	19	256
September	696	25	24	20	192	169	22	18	226
October	686	25	23	20	188	169	23	18	220
November	640	16	24	20	183	154	23	16	204
December	592	18	21	20	168	143	23	16	183
Boys under 16 years—									
January	2					2			
February	3			1		2			
March	3			1		2			
April	3			1		2			
May	3			1		2			
June	3			1		2			
July	3			1		2			
August	3			1		2			
September	3			1		2			
October	3			1		2			
November	3			1		2			
December	4			2		2			
Miscellaneous expenses:									
Total	$42,410	$685	$2,577	$300	$6,720	$13,275	$696	$1,085	$17,072
Royalties and rent of mine and mining plant	$8,421	$175	$2,094		$1,711	$2,198	$588	$1,050	$605
Rent of offices, taxes, insurance, interest, and other sundries	$33,989	$510	$483	$300	$5,009	$11,077	$108	$35	$16,467
Cost of supplies and materials	$80,309	$1,625	$1,617	$1,455	$12,264	$23,384	$926	$205	$38,833
Value of product	$1,157,711	$21,275	$12,895	$16,950	$189,345	[1] $587,284	$20,738	$16,335	[2] $292,889
Power:									
Total horsepower	2,495	21	80	31	275	647	35	200	1,206
Owned—									
Engines—									
Steam—									
Number	71	2	2	4	3	23	1	2	34
Horsepower	2,300	21	80	27	265	635	35	200	1,037
Gas or gasoline—									
Number	7			1					6
Horsepower	88			4					84
Other power—									
Number	3				1				2
Horsepower	95				10				85
Rented—									
Other than electric—									
Horsepower	12					12			
Electric motors owned—									
Number	1								1
Horsepower	5								5

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[1] Includes product valued at $408,598 obtained in quarries producing other than abrasive materials.

[2] Includes product valued at $35,941 obtained in quarries producing other than abrasive materials.

TABLE 5.—DETAILED SUMMARY, BY CLASSES: 1902.

	All abrasives.	Buhrstones and millstones.	Corundum and emery.	Crystalline quartz.	Garnet.	Grindstones and pulpstones.	Infusorial earth, tripoli, and pumice.	Oilstones, whetstones, and scythestones.
Number of mines or quarries	82	29	5	6	7	9	11	15
Number of operators	75	29	5	5	7	9	10	10
Character of ownership:								
Individual	39	23	1	3	1	1	3	7
Firm	17	6			3	3	4	1
Incorporated company	19		4	2	3	5	3	2
Salaried officials, clerks, etc.:								
Total number	75	7	9	8	12	25	8	6
Total salaries	$48,008	$4,682	$5,960	$6,030	$9,178	$13,042	$4,016	$5,100
General officers—								
Number	16	1	4	2	2	2	1	4
Salaries	$13,101	$471	$2,950	$2,000	$2,150	$480	$1,000	$4,050
Superintendents, managers, foremen, surveyors, etc.—								
Number	43	6	2	4	6	18	5	2
Salaries	$25,506	$4,211	$1,199	$2,830	$4,028	$10,132	$2,056	$1,050
Foremen below ground—								
Number	1		1					
Salaries	$600		$600					
Clerks—								
Number	15		2	2	4	5	2	
Salaries	$8,801		$1,211	$1,200	$3,000	$2,430	$960	
Wage-earners:								
Aggregate average number	610	86	47	29	118	210	35	85
Aggregate wages	$296,914	$39,562	$32,871	$13,592	$59,632	$99,598	$13,682	$37,977
Above ground—								
Total average number	585	86	25	29	118	210	32	85
Total wages	$280,416	$39,562	$18,271	$13,592	$59,632	$99,598	$11,784	$37,977
Engineers, firemen, and other mechanics—								
Average number	75	4	6	1	10	48	2	4
Wages	$43,772	$2,264	$5,525	$600	$4,914	$27,110	$930	$2,429
Miners or quarrymen, and stonecutters—								
Average number	387	80	11	26	61	118	20	71
Wages	$176,798	$36,734	$5,546	$12,392	$29,505	$54,270	$7,254	$31,097
Boys under 16 years—								
Average number	3					2		1
Wages	$912					$537		$375
All other wage-earners—								
Average number	120	2	8	2	47	42	10	9
Wages	$58,934	$564	$7,200	$600	$25,213	$17,681	$3,600	$4,076
Below ground—								
Total average number	25		22				3	
Total wages	$16,498		$14,600				$1,898	
Miners—								
Average number	15		12				3	
Wages	$10,648		$8,750				$1,898	
Miners' helpers—								
Average number	10		10					
Wages	$5,850		$5,850					
Average number of wage-earners at specified daily rates of pay:								
Engineers—								
$1.25 to $1.49	1				1			
$1.50 to $1.74	9	1			2	3	2	1
$1.75 to $1.99	1				1			
$2.00 to $2.24	22			1		20		1
$2.25 to $2.49	3		2					1
$2.50 to $2.74	2	1	1					
$3.00 to $3.24	1					1		
$3.50 to $3.74	1		1					
Firemen—								
$1.00 to $1.24	1				1			
$1.75 to $1.99	14					14		
Machinists, blacksmiths, carpenters, and other mechanics—								
$0.75 to $0.99	1				1			
$1.50 to $1.74	3	1			1	1		
$1.75 to $1.99	7				1	6		
$2.00 to $2.24	7	1			2	3		1
$2.25 to $2.49	1		1					
$4.00 to $4.24	1		1					
Miners or quarrymen, and stonecutters—								
$0.75 to $0.99	13				12			1
$1.00 to $1.24	38	4				9	14	11
$1.25 to $1.49	66	14			1	43	4	4
$1.50 to $1.74	160	40	8	21	10	32	1	48
$1.75 to $1.99	70	16	8	4	18	24		
$2.00 to $2.24	35	5		1	20	1	3	5
$2.25 to $2.49	4					3		1
$2.50 to $2.74	7					6		1
$2.75 to $2.99	1	1						
$3.00 to $3.24	8		7				1	
Miners' helpers—								
$1.50 to $1.74	5		5					
$1.75 to $1.99	5		5					
Boys under 16 years—								
$0.75 to $0.99	2					2		
$1.25 to $1.49	1							1
All other wage-earners—								
$0.75 to $0.99	6				6			
$1.00 to $1.24	14			2		2	10	
$1.25 to $1.49	16	2			1	13		
$1.50 to $1.74	35					27		8
$1.75 to $1.99	21				20			1
$2.00 to $2.24	20				20			
$2.50 to $2.74	6		6					
$3.00 to $3.24	2		2					

TABLE 5.—DETAILED SUMMARY, BY CLASSES: 1902—Continued.

	All abrasives.	Buhrstones and millstones.	Corundum and emery.	Crystalline quartz.	Garnet.	Grindstones and pulpstones.	Infusorial earth, tripoli, and pumice.	Oilstones, whetstones, and scythe stones.
Average number of wage-earners employed during each month								
Men 16 years and over—								
January	427	74	36	17	62	149	29	60
February	437	76	37	17	62	153	29	63
March	475	87	35	17	68	165	29	74
April	625	92	38	27	157	193	31	87
May	639	98	47	28	113	212	38	103
June	673	86	56	29	135	231	38	98
July	675	85	59	28	135	228	36	104
August	700	83	51	44	135	249	36	102
September	696	85	59	40	145	243	37	87
October	696	91	55	34	138	248	39	91
November	639	95	42	34	140	218	39	71
December	592	79	49	34	116	207	39	68
Boys under 16 years—								
January	2					2		
February	3					2		1
March	3					2		1
April	3					2		1
May	3					2		1
June	3					2		1
July	3					2		1
August	3					2		1
September	3					2		1
October	3					2		1
November	3					2		1
December	4					2		2
Miscellaneous expenses:								
Total	$42,410	$1,480	$2,779	$1,950	$4,952	$24,133	$5,563	$1,553
Royalties and rent of mine and mining plant	$8,421	$636	$1,091	$1,825	$1,341	$2,003	$1,050	$475
Rent of offices, taxes, insurance, interest, and other sundries	$33,989	$844	$1,688	$125	$3,611	$22,130	$4,513	$1,078
Cost of supplies and materials	$80,309	$1,850	$26,111	$950	$10,128	$31,309	$2,299	$7,662
Value of product	$1,177,711	[1]$59,868	$104,605	$43,085	$132,820	[2]$667,431	[3]$55,994	[4]$113,908
Power:								
Total horsepower	2,495	85	110	20	430	1,247	410	193
Owned—								
Engines—								
Steam—								
Number	71		2	1	7	41	7	13
Horsepower	2,300		30	20	420	1,235	410	185
Gas or gasoline—								
Number	7		3					4
Horsepower	88		80					8
Other power—								
Number	3	2			1			
Horsepower	95	85			10			
Rented—								
Other than electric—								
Horsepower	12					12		
Electric motors owned—								
Number	1						1	
Horsepower	5						5	

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[1] Includes $1,425 quarried with granite.

[2] Includes $463,066 quarried with sandstone.

[3] Includes $1,436 mined with talc and soapstone.

[4] Includes $38,612 quarried with sandstone.

BORAX

BORAX.

By Joseph Struthers, Ph. D.

The first commercial production of borax in the United States was in 1864, when 12 short tons were mined in California. Since that year the production has fluctuated from nothing in 1869, 1870, and 1871, to 19,142 short tons in 1902. Up to the present investigation borax has never been separately treated in the census of mines and mining. Table 1 is a summary of the statistics for 1902.

TABLE 1.—*Summary: 1902.*

Number of mines or quarries	6
Number of operators	6
Salaried officials, clerks, etc.:	
Number	14
Salaries	$18,128
Wage-earners:	
Average number	153
Wages	$114,865
Miscellaneous expenses	$47,608
Cost of supplies and materials	$213,589
Product:[1]	
Quantity, short tons	19,142
Value	$2,383,614

[1] The United States Geological Survey reports 20,004 short tons, valued at $2,538,614, which includes 862 short tons of boric acid, valued at $155,000. This acid representing a manufacture, is not reported by the Census.

There were only 6 productive mines or quarries in 1902, and these were not widely separated geographically. Four were in California, and 1 each in Nevada and Oregon. Each company operated a single mine only. An average of about 25 wage-earners for each mine is shown. For the industry as a whole a total average for the year of only 167 salaried employees and wage-earners is reported. Compared with the amount paid in wages and salaries and for miscellaneous expenses, the cost of supplies and materials appears large.

Six mines were idle in 1902—3 in California, 2 in Nevada, and 1 in Oregon—and at 1 mine in California development work was carried on.

Capital stock of incorporated companies.—Every active company reported was organized as a corporation. Their capitalization appears in Table 2.

TABLE 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	6
Capital stock:	
Total authorized—	
Number of shares	823,750
Par value	$3,175,000
Total issued—	
Number of shares	822,250
Par value	$3,025,000
Dividends paid	$231,600
Common—	
Authorized—	
Number of shares	573,750
Par value	$2,925,000
Issued—	
Number of shares	572,250
Par value	$2,775,000
Dividends paid	$231,600
Preferred—	
Authorized—	
Number of shares	250,000
Par value	$250,000
Issued—	
Number of shares	250,000
Par value	$250,000

These companies, as a rule, refine the crude borax, and it must be remembered that the capitalization shown includes that utilized for the equipment and maintenance of the refining plants. Refining, however, is too closely related to mining to allow of satisfactory segregation.

The par value of the total amount of capital stock authorized for these companies was $3,175,000, representing 823,750 shares of both common and preferred stock. Shares to the number of 822,250, with a par value of $3,025,000, were issued. Of these 572,250 shares were of common stock with a par value of $2,775,000, and 250,000 shares were of preferred stock with a par value of $250,000. All the preferred stock authorized was issued, as was all but 1,500 shares of the common stock. There was paid $231,600 in dividends on the common stock issued. This is equivalent to 8.35 per cent on its par value. No dividend was paid upon the preferred stock. There was no bonded indebtedness.

Employees and wages.—The average number of wage-earners employed during each month of 1902, and the daily rates of pay, are shown in Table 6. The importance of this industry is not to be judged by the number of men to whom it gave employment, only 174 at the maximum, during the cool months of the year. In summer, from June until September, the heat in the southeastern counties of California does not permit active operations, which as a consequence are reduced to a minimum. On the coming of cooler weather, however, operations are at once resumed, as appears from the number of men reported employed in September and October.

Here relatively high rates of pay are shown. Fifty per cent of the engineers received from $3.25 to $3.49 per diem; 3 of the 6 mechanics got above $3.50 per diem. Over 71 per cent of those classed as miners or quarrymen received from $2.50 to $3.24 per diem. All of the miners' helpers received from $2.50 to $2.74. Of "all other wage-earners" none was paid less than $1.50 per diem, and more than two-thirds, or 67.4 per cent, received from $2 to $3.24.

Mechanical power.—Mechanical power to the amount of 338 horsepower was reported. Two hundred and five horsepower were furnished by 5 steam engines, 123 horsepower by 11 gas or gasoline engines, and 10 horsepower by 1 water wheel. There was also 1 electric motor of 1 horsepower.

Production.—Table 3 shows the annual production of borax in California from 1889 to 1902, as reported by the United States Geological Survey.

TABLE 3.—*Production of borax in California: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States, 1902.]

YEAR.	Quantity (short tons).	Value.
1889	965	$145,473
1890	3,201	480,152
1891	4,267	640,000
1892	5,525	838,787
1893	3,955	653,292
1894	5,770	807,807
1895	5,959	595,900
1896	6,754	675,400
1897	8,000	1,080,000
1898	8,300	1,153,000
1899	20,357	1,139,882
1900	25,837	1,013,251
1901	23,231	1,012,118
1902[1]	20,004	2,538,614

[1] Includes small quantities and value of same, mined in Oregon and Nevada. To separate would reveal the operations of single operators.

Since 1864, when the first production was reported, 156,354 short tons of borax have been produced in California. This is practically the production for the whole United States. Prior to 1890 the number of short tons produced annually had passed the thousand mark only in 1875, 1876, 1884, 1886, 1887, and 1888. In 1889 the production sank slightly below this mark, only to rise with a bound in 1890 to 3,201 tons, the greatest up to that time. From then until 1900, with the exception of 1893 when there was a temporary setback, it gradually increased to 25,837 tons. In 1901 a production of 23,231 tons was reported, and in 1902, 19,142 tons, exclusive of the 862 tons of boric acid reported by the Geological Survey. The decrease in output for these years is apparent only, for it must be borne in mind that the figures of production are for both crude and refined, and that the proportions of each may vary greatly each year. The tendency of late years has been to do as much refining or concentrating as is possible at the place of production. Thus in 1902, while 43,010 short tons of crude ore were mined, 40,410 tons of this received some treatment at the mines, making 16,542 tons of refined product, which, with the remaining 2,600 tons of crude, comprise the 19,142 tons reported.

Table 4 gives the production of borax and boron compounds in the principal producing countries of the world from 1896 to 1901, inclusive, as reported by the United States Geological Survey.

TABLE 4.—*The production of borax, borates, etc., in the principal countries of the world: 1896 to 1901.*[1]

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Metric tons.]

YEAR.	United States (calcium borate).	Chile (calcium borate).[2]	India (borax).[2]	Germany (boracite).	Italy (boric acid, crude).	Peru (calcium borate).[2]	Turkey (pandermite).[2,3]
1896	12,310	7,486	340	184	2,616	1,179	12,626
1897	17,600	3,168	290	198	2,704	11,850	11,375
1898	13,911	7,034	184	230	2,650	7,178	(4)
1899	21,834	14,951	250	183	2,674	7,638	(4)
1900	23,456	13,177	224	232	2,491	7,080	(4)
1901	16,227	11,547	162	184	2,558	(5)	(4)

[1] From official reports of the respective countries, except the United States.
[2] Exports.
[3] Fiscal years.
[4] Total exports, 1897 to 1901, amounted to 43,861 tons, valued at £789,318.
[5] Statistics not yet available.

The control of the borax industry in the world is now practically in the hands of the Borax Consolidated (Limited), an international trade combination which was formed in 1898 with a capital stock of £1,400,000 to acquire all the important borax-producing properties in the world. This concern owns or controls borax lands and refineries in the United States, England, France, Chile, Peru, and Turkey.

The future of the borax industry indicates an increased demand for borax and boric acid, as well as an increase in the number of industrial purposes to which these and their compounds are applicable. At the present time the various industries in which boron compounds are used include the manufacture of earthen, china, and glass ware, enameled ironware, smelting, tanning, calico printing, cement making, color manufacture, bleaching, soapmaking, and meat packing. Boron compounds are also used in laundries and for many household, toilet, and surgical purposes.

There has been considerable discussion as to the use of boric acid as a preservative for food, and the preponderance of the evidence seems to be in favor of its employment in small quantities as an entirely harmless preservative, but only a small proportion of the total supply in the world is utilized for this purpose.

In order to provide data from which may be calculated an estimate of the consumption of borax and boron salts in the United States, Table 5, showing the imports, has been prepared by the United States Geological Survey from the reports of the United States Treasury Department.

TABLE 5.—*Imports of borax and borates into the United States: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States" 1902.]

YEAR.	BORAX.		BORATES, CALCIUM, AND SODIUM (CRUDE AND REFINED SODIUM BORATE).		BORIC ACID.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1889	....	....	Nil.	Nil.	676,736	$38,814
1890	....	....	29,608	$900	867,802	43,967
1891	....	....	414,151	17,681	666,765	41,019
1892	....	....	40	6	701,625	39,118
1893	11,239	$1,327	543,967	13,659	771,775	40,568
1894	1,812	225	441,066	11,427	298,980	19,282
1895	612,730	26,429	4,284,261	105,604	925,158	42,076
1896	11,376	796	4,307,100	104,951	555,769	21,829
1897	19,087	1,128	5,204,612	79,268	....	....
1898	10,232	962	4,235,856	92,108	....	....
1899	51,221	3,608	42,165	2,979	582,002	20,560
1900	273,706	9,937	58,294	4,306	473,251	17,436
1901	545,045	20,643	109,700	9,411	725,005	26,629
1902	694,837	20,796	186,807	12,002	822,907	30,139

A detailed summary showing the statistics for borax during 1902 is given in Table 6.

DESCRIPTIVE.

Historical.—The occurrence of borax in the United States was discovered in California by Dr. John A. Veatch, January 8, 1856. Having boiled a small quantity of water from Lick Spring (then known as Tuscan Spring), Doctor Veatch noticed that, as the water cooled, crystals formed and adhered to the sides of the vessel. These crystals proved later to be sodium biborate, or borax. Shortly afterwards Doctor Veatch found small quantities of borax at the mouth of the Pitt river, in Shasta county, and traces of this salt in numerous springs in the Coast Range mountains; but it was not until September, 1856, that he discovered the extensive marsh deposits on the eastern side of Clear Lake, in Lake county, which subsequently furnished a large share of the borax produced in the United States.

The year 1864 witnessed the beginning of the borax industry in this country. In that year 12 short tons (24,304 pounds) of borax were obtained by evaporating the saline waters from Borax Lake, adjacent to and connected with Clear Lake, in Lake county, 80 miles north of San Francisco. Later the waters of the lake were enriched by the addition of crystalline borax collected from the alkaline marshes surrounding the lake.

Until the early seventies, the output of borax in California was obtained solely from the waters of Clear Lake and other lakes in the state, but after that time the discovery of large quantities of pure borax in many of the alkaline marshes in eastern California and western Nevada, caused the abandonment of the lake refineries and the erection of new plants, notably near Columbus, Nev.; at Searles marsh in the Amargosa valley; and at the mouth of Furnace creek in Death Valley, California. Despite the difficulty and great cost of transporting the refined product by teams 100 miles to the railroad, the refineries continued in successful operation for several years, until the relatively large increase in the domestic output, together with the increased imports from Italy, so reduced the price that the working of the marsh deposits became no longer profitable and the refineries were closed down. About the year 1890 it was found that the borax crust on many of the marshes had been formed by the leachings of beds of calcium borate (borate of lime) in the Tertiary lake sediments in that region. Owing to the large extent of these bedded deposits, which possessed also the double advantage of containing a purer grade of mineral and of being more easily accessible than the marsh deposits, the borax industry as it existed at that time was revolutionized. A mine was started on a bedded deposit of from 6 to 10 feet in thickness at Borate, 12 miles northeast of Daggett, Cal., in San Bernardino county, and a refining plant was erected by the Pacific Coast Borax Company. This company was organized in 1888, and at the present time is the chief producer of borax in the United States, as well as the producer of a large part of the output of boric acid. The ore at Borate consists of colemanite (a calcium borate mineral) in large masses more or less connected by stringers and bands in a bedded deposit of from 5 to 30 feet in thickness, interstratified in lake sediments. The great value of this deposit led to extensive prospecting in other parts of the state, which has resulted in the discovery in Death Valley of enormous quantities of colemanite reported to exceed greatly in [illegible]alue the deposit at Borate. Both at Borate and in [illegible]th Valley the deposits are of similar occurrence, [illegible] contained in a regular stratum interbedded with sem[illegible] indurated sands and clays which comprise the bulk of the strata. These beds are regarded as of Tertiary age, and are supposed to have been deposited from inclosed bodies of water. Large plants for the concentration and refining of the crude ore have been erected in California: At Alameda, near San Francisco (inoperative during 1902), at Marion, and at Daggett. The largest borax refinery in the United States, however, is at Bayonne, New Jersey.

Review of the borax industry during 1902.—There were 4 companies engaged in the borax industry in California during 1902—the Pacific Coast Borax Company, the American Borax Company, the Western Borax Works, and the Frazier Borate Mining Company. The Pacific Coast Borax Company, continued to supply a sufficient quantity of borax to satisfy the requirements of the market; and apart from its operations at Borate, prospecting work for other colemanite deposits has been carried on in Death Valley and much additional property has been acquired. The deposits in Amargosa Valley were carefully examined and large sample lots of ore were transported by traction engines to Manville, 100 miles distant, and thence by rail to the refinery for testing the quality, in order to determine the value of the property. The large borax refinery at Bayonne, N. J., was destroyed by fire in April, 1902, but has since been entirely rebuilt.

The American Borax Company, is under the control of the Standard Sanitary Company, of Pittsburg, Pa. The plant of this concern at Daggett has been greatly extended by the addition of two 20,000-gallon tanks or digesters for the treatment of the crude material from the adjacent mud deposits by the sulphuric acid process, which is referred to in detail later in this report. The enlargement of this plant has greatly increased the output of boric acid concentrates, and the results have been so satisfactory that a further extension of the plant at Daggett is contemplated. A new refinery is in course of erection at Pittsburg, to which will be shipped the concentrates from Daggett for the final refining.

The mines of the Western Borax Works are located in Inyo county, and those of the Frazier Borate Mining Company in San Bernardino county.

Apart from the output of the above-named concerns, a small quantity of borax has been obtained from the marsh deposits in California and Nevada, but the total amount produced from these scattered sources has been of so little comparative importance that the borax market was in no way affected. During the past few years Oregon has contributed to the domestic supply a small quantity of borax from the marsh deposits in Harney county. The output has averaged about 400 tons annually except in 1902, when 120 tons were reported, as the mining operations had given way greatly to development work. The chief borax producer in this state is the Rose Valley Borax Company, controlling 2,000 acres of rich marsh land near Lake Alvord in the southeastern part of Harney county. The total area of the deposit, which is south of the lake, aggregates approximately 10,000 acres. The ground is level and treeless, and is incrusted with a layer several inches thick containing in addition to sodium borate numerous other salts of sodium. During the long summer months the loose surface deposit is shoveled into small heaps, and is subsequently replaced with a second incrustation within a comparatively short period of time. The stock of crude material collected during the summer is sufficient to enable the refinery to continue in operation throughout the entire year. The crude mineral, containing from 5 to 20 per cent of boric acid in combination with a sodium base, is shoveled into tanks containing boiling water to which is added a proper quantity of chlorine gas or sulphuric acid to decompose the alkali salts and thus liberate the boric acid. After a treatment of twenty-four hours in the tank the clear supernatant liquor is withdrawn to the crystallizing vats and allowed to cool, which causes the boric acid to separate in the form of crystals, leaving a mother liquor, which is used repeatedly until it contains sufficient sodium salts to warrant a separate treatment.

Occurrence.—The principal minerals containing boron are as follows: Sassolite, boric acid (H_3BO_3); borax (tincal), sodium biborate ($Na_2B_4O_7.10H_2O$); ulexite (boronatrocalcite) ($CaNaB_5O_9.8H_2O$); colemanite (impure varieties, priceite and pandermite), calcium borate ($Ca_2B_6O_{11}.5H_2O$); and boracite (stassfurtite), magnesium borate ($2Mg_3B_8O_{15}.MgCl_2$). Boron is also a constituent of several common silicate minerals, notably tourmaline and datolite. Borax, sodium biborate ($Na_2B_4O_7.10H_2O$), is the only important salt derived from boric acid. It occurs native in California, Ceylon, and Thibet, and from the last-named place it is obtained in the form of tincal, an impure crystallized borax containing calcium and magnesium sulphates and chlorides and a greasy substance which is added presumably to protect the crystals from efflorescence and breakage. The tincal is purified by dissolving in warm water and adding limewater and calcium chloride in order to precipitate the grease as a lime soap. After filtering, the pure crystals of boric acid are obtained by evaporating the solution.

Physical and chemical characteristics.—Several forms of borax are used in industrial, medicinal, and laboratory processes—the principal one being prismatic sodium borate (borax, $Na_2B_4O_7.10H_2O$). There is a second variety called "octahedral borax" which contains five molecules of water of crystallization ($Na_2B_4O_7.5H_2O$), forming octahedral crystals. The latter variety, unlike prismatic borax, becomes opaque upon exposure to moist air and is converted by the absorption of water into the prismatic form.

A property of molten borax of great utility in analytical research is that of dissolving various metallic oxides, thereby forming transparent glasses of characteristic colors. By making a borax bead on a loop of platinum wire held in a blowpipe flame, and dissolving therein the substance under examination, the presence of certain metals is easily distinguished.

Borax is also of great value in assaying gold and silver ores, being used to dissolve and remove the base metals from the metallic lead button containing the gold and silver of the sample of ore tested. This property of dissolving oxides is utilized also in soldering and brazing metals that are oxidizable by heat; the molten borax absorbing any oxides formed whose presence mechanically would prevent the close adhesion of the metals so necessary for a proper weld or soldered joint.

Among other important uses are as a constituent of strass or paste for making glass and enamels; as a glaze for fine earthenware; in combination with shellac as a varnish for stiffening felt hats; with casein as a substitute for gum arabic, and (on account of its antiseptic qualities) as a household soap; as an ingredient of various cosmetics; and as a solution for cleansing the hair.

Boric acid (H_3BO_3) (old name boracic acid): In Tuscany the vapors escaping from the hot springs and from openings in the ground (fumaroles) contain boric acid, and in some places this substance is obtained as crystals by the evaporation of water from these fumaroles. The crystals or crusts produced naturally form the mineral sassolite. The crystals of boric acid are white in color, laminated in structure, and possess a mother-of-pearl luster. They dissolve readily in hot water though very slightly in cold. Upon being heated to 160° C. they lose one-half the water of crystallization and become transformed to pyroboric acid ($H_2B_4O_7$). At a red heat all of the water is expelled and boric anhydride (B_2O_3) results, which, even at high temperatures is stable and nonvolatile, and for this reason it is able to decompose nearly all of the metallic sulphates, forming when fused with them, metallic borates.

Fused boric anhydride when cold resembles ordinary glass in transparency, hardness, and brittleness. The chief uses of boric acid are in the manufacture of borax; in making colored glazes for the decoration of iron, steel, and other metallic objects; in enamels and glazes for pottery; in the manufacture of flint glass and strass or paste from which artificial stones are cut; in making Guignet's green; as an antiseptic in medicine and surgery; and as a preservative for fish, meat, milk, and other foods.

The principal methods used in the manufacture of boric acid are thus described:

The chlorine or Moore process. In this process, which is used to some extent in England, the crude colemanite in powdered form is suspended in water and heated to 70° C.; then chlorine gas is passed into the liquor and reacts on the colemanite, forming boric acid, calcium chloride, and calcium chlorate. The greater part of the boric acid crystallizes out upon cooling and is subsequently purified by repeated crystallizations. The residue solution, called mother liquor, is used many times until the accumulated calcium salts begin to separate out in the form of crystals.

The hydrochloric acid process.—The mode of procedure in this process is as follows: Two parts by weight of hydrochloric acid and four parts of water (the volume of the latter being kept constant) are used, in which the calcium borate is boiled until dissolved. The boric acid is then crystallized out of the cooled liquor, leaving the calcium chloride still in solution. Before the crystals are in proper condition for packing and shipping, an additional treatment is necessary, which consists of draining, "whizzing," and washing with cold water, concluding with a second and final "whizzing." In Germany the hydrochloric acid process is used to extract the boric acid from the boracite contained in the famous Stassfurt salt deposits. The material is crushed and treated with hydrochloric acid, the resultant pasty mass is dissolved in boiling water and the solid material separated and removed by filtration or decantation; the clear solution is then crystallized in iron tanks, yielding pure crystals of boric acid. The chemical reaction involved is $(2Mg_3B_8O_{15}), MgCl_2+12HCl+18H_2O=7MgCl_2+16H_3BO_3$.

The sulphuric acid process.—In this process calcium borate is treated with sulphuric acid, the reaction yielding soluble boric acid and precipitated calcium sulphate. The boric acid is obtained by leaching with hot water, the solution so produced being concentrated by evaporation until the crystals of boric acid separate out from the solution. In California the process is slightly modified. The borate mud is boiled in huge tanks with water containing sulphurous acid, which decomposes the calcium borate, thereby liberating the boric acid in the solution and leaving the calcium in the form of insoluble calcium sulphate. As before, the boric acid is dissolved by leaching with hot water, which, however, extracts also a small quantity of other soluble salts. For this reason fractional crystallization is necessary in order to obtain a fairly pure product. In a few works the insoluble calcium sulphate is separated and removed by passing the muddy solution from the tanks through filter presses.

The sulphuric acid process is sometimes used to decompose the boracite of the Stassfurt deposits, and in this case Epsom salt is obtained as a by-product from the magnesium sulphate contained in the mother liquor, according to the following chemical reaction: $(2Mg_3B_8O_{15}), MgCl_2 + 7H_2SO_4 + 18H_2O = 7MgSO_4 + 2HCl+16H_3BO_3$.

The ammonia process or bigot process.—Boric acid is produced by heating in a closed vessel 100 parts of colemanite and 150 parts of ammonium sulphate. The product of the first reaction is ammonium borate, which is later decomposed into ammonia and boric acid. The ammonia is condensed and collected, and the boric acid is dissolved from the residuum by leaching with water and concentrating the resultant aqueous solution until crystals of boric acid are formed. The crystals are then removed, washed with water until free from adhering mother liquor, dried, and packed for shipment to the market. At times the crystals are ground to a fine powder before being packed and shipped.

The manufacture of borax from boric acid. The process generally used to make borax from boric acid is briefly summarized as follows: Equal quantities of crystallized sodium carbonate and water are heated by steam in a lead-lined vessel, and to the solution thus obtained sufficient boric acid is gradually added to combine with the sodium carbonate and form the borax salt $(Na_2B_4O_7), 10H_2O$. Another process is to prepare solutions of ammonia, sodium nitrate, and boric acid in the proportions of two, one, and two, respectively. By heating this mixture and dissolving in water, borax and ammonium nitrate are formed. In both of these cases the crystals of borax are ultimately obtained by the evaporation of the solutions containing the borax salt.

The manufacture of borax from colemanite.—At the borax refinery in Alameda, Cal., the process used to convert colemanite into borax crystals is briefly outlined as follows: The crude colemanite, obtained direct from the mines, is first broken into lumps of from three-fourths to 1½ inches in diameter, then reduced in a grinding mill to the size of fine sand, and finally passed through rolls which grind the material to the fineness of flour. The floured product is transferred to an iron tank partly filled with water containing in solution the proper proportion of sodium carbonate necessary to decompose the calcium borate. (A ready and cheap supply of sodium carbonate is obtained from Owens Lake, Cal.) Heat is applied to the tank and the contents boiled and thoroughly agitated by means of a mechanical agitator. After a short time the chemical reaction has become completed, the double decomposition being the change from calcium borate and sodium carbonate to calcium carbonate and sodium borate. The sodium borate being soluble is extracted from the insoluble calcium carbonate by leaching with hot water, which dissolves in addition a small quantity of other soluble salts from the impurities in the ore and sodium carbonate. As a consequence the crystals of borax obtained by cooling and evaporating this solution in tanks are of a dark color and somewhat impure. They are purified by a second solution in hot water and a second crystallization in a special vat having a series of suspended wires on which the purer borax crystals form. The crystals on the sides and bottom of the vat are less pure. The purified crystals of borax are removed from the vats, washed free from adhering mother liquor, dried, ground, and screened into several grades for the market.

At the Marion (Cal.) works the crude colemanite ore is submitted to a concentration, and the rich concentrates are shipped to the refinery at Bayonne, N. J., for final conversion into borax. These concentrates are in two forms, lumps and fines. Formerly the low grade ores at Marion were rejected, but at the present time they are heated in a two-hearth, 100-ton Holthoff-Wethey furnace, fired by six oil burners. A gentle heat suffices to cause the colemanite in the ore to disintegrate physically into a sand-like product called "flour," which is removed when cold by screening, and is sacked and shipped to the Bayonne refinery. One disadvantage of the separation of the colemanite by heating in a furnace is that any pandermite (the compact variety of the mineral) present in the ore is not affected by the heat, and is consequently left in the waste material remaining in the screens. At times the waste equals in quantity one-half of the "flour" product.

The conversion of the colemanite into borax at the Bayonne refinery in New Jersey is made by decomposing the calcium borate with sodium carbonate, leaching out the sodium biborate with water, yielding a solution which is separated from the insoluble calcium carbonate by passage through a filter press at a pressure of from 50 to 100 pounds per square inch. The clarified solution is transferred to vats having wires suspended from 2-inch iron pipes extending across the top of the vat. The crystals of borax form on these wires as well as on the sides and bottom of the vat, those on the wires being sufficiently pure for all trade requirements, while those on the sides and bottom of the vat have to be redissolved and purified by a second crystallization. The pure crystals are crushed, screened, and sorted into three grades—refined crystals, refined screenings, and granulated borax. The crystals and screenings are packed for the market, but the granulated borax before shipment undergoes a final treatment, which consists of heating in an inclined rotating cylindrical furnace, crushing to the fineness of flour in a pulverizer, settling and collecting the dust in a large dust chamber, and packing the final product for market. The Bayonne refinery is well equipped with all modern mechanical devices for the handling and treatment of the crude and finished materials.

TABLE 6.—*Detailed summary: 1902.*

Number of mines or quarries	6
Number of operators	[1]6
Character of ownership:	
Incorporated company	6
Salaried officials, clerks, etc.:	
Total number	14
Salaries	$18,128
General officers—	
Number	1
Salaries	$1,800
Superintendents, managers, foremen, surveyors, etc.—	
Number	7
Salaries	$10,798
Foremen below ground—	
Number	3
Salaries	$3,180
Clerks—	
Number	3
Salaries	$2,350
Wage-earners:	
Aggregate average number	153
Aggregate wages	$114,865
Above ground—	
Total average number	76
Total wages	$52,811
Engineers, firemen, and other mechanics—	
Average number	17
Wages	$14,257
Miners or quarrymen—	
Average number	21
Wages	$13,300
All other wage-earners—	
Average number	38
Wages	$25,254
Below ground—	
Total average number	77
Total wages	$62,054
Miners—	
Average number	45
Wages	$37,246
Miners' helpers—	
Average number	27
Wages	$20,550
All other wage-earners—	
Average number	5
Wages	$4,258
Average number of wage-earners at specified daily rates of pay:	
Engineers—	
$1.75 to $1.99	1
$2.00 to $2.24	2
$3.00 to $3.24	1
$3.25 to $3.49	4

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[1] Includes operators distributed as follows: California, 4; Nevada, 1; Oregon, 1.

TABLE 6.—*Detailed summary: 1902*—Continued.

Average number of wage-earners at specified daily rates of pay—Con.	
Firemen—	
$2.00 to $2.24	2
$2.75 to $2.99	1
Machinists, blacksmiths, carpenters, and other mechanics—	
$1.50 to $1.74	3
$3.50 to $3.74	2
$4.00 to $4.24	1
Miners or quarrymen—	
$1.50 to $1.74	8
$2.00 to $2.24	11
$2.50 to $2.74	20
$3.00 to $3.24	27
Miners' helpers—	
$2.50 to $2.74	27
All other wage-earners—	
$1.50 to $1.74	11
$1.75 to $1.99	3
$2.00 to $2.24	1
$2.25 to $2.49	13
$2.50 to $2.74	13
$3.00 to $3.24	2
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	170
February	170
March	174
April	174
May	174
June	96
July	96
August	96
September	168
October	174
November	174
December	170
Miscellaneous expenses:	
Total	$47,606
Royalties and rent of mine and mining plant	$19,200
Rent of offices, taxes, insurance, interest, and other sundries	$28,406
Cost of supplies and materials	$213,538
Product	
Total—	
Quantity, short tons	19,142
Value	$2,383,614
Crude—	
Quantity, short tons	2,600
Value	$91,000
Refined—	
Quantity, short tons	16,542
Value	$2,292,614
Power owned:	
Total horsepower	338
Engines—	
Steam—	
Number	5
Horsepower	205
Gas or gasoline—	
Number	11
Horsepower	128
Water wheels—	
Number	1
Horsepower	10
Electric motors—	
Number	1
Horsepower	1

FLUORSPAR

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FLUORSPAR.

By Joseph Hyde Pratt.

The mining of fluorspar has increased very greatly since the census of 1890, due to the large increase in the use of this mineral in metallurgical processes, especially in the iron industry. For some years the use of fluorspar for fluxing iron was not large, because it was feared a constant supply could not be obtained. At that time the mineral was produced in only one state, Illinois, although it was known to occur in small quantity in a number of other states. Now, however, it has been proved to occur in commercial quantity in Arizona, Illinois, Kentucky, and Tennessee.

The first census statistics for fluorspar were collected at the Eleventh Census, and these are compared with the statistics for 1902 in the following table:

Table 1.—*Comparative summary: 1902 and 1889.*

	1902	1889
Number of mines	22	(1)
Number of operators	18	(1)
Salaried officials, clerks, etc.:		
Number	42	(1)
Salaries	$27,311	(1)
Wage-earners:		
Average number	269	101
Wages	$110,002	$14,213
Contract work	$300	(1)
Miscellaneous expenses	$23,602	$3,008
Cost of supplies and materials	$31,374	$5,025
Product:[2]		
Quantity, short tons	48,818	9,500
Value	$275,682	$45,835

[1] Not reported.

[2] The United States Geological Survey reports 48,018 short tons, valued at $271,832, which is the product marketed. Census figures represent the product mined.

Less than one-tenth of the total quantity and about one-fifth of the entire value reported for 1902 represent the product prepared at the mine for the market, the preparation consisting of drying and grinding, in addition to the usual washing.

Of the 22 mines in 1902, 14 were in Kentucky, 5 in Illinois, 2 in Arizona, and 1 in Tennessee. The product has increased from 9,500 tons in 1889 to 48,818 tons in 1902, or over fivefold, and the value from $45,835 to $275,682, or over sixfold. In these twelve years, Illinois, which was the only state producing fluorspar commercially in 1889, has increased its production from 9,500 tons, valued at $45,835, to 18,860 tons, valued at $123,000, or 98.5 per cent in amount and 168.4 per cent in value. One mine in Kentucky was reported idle in 1902. At two mines in Illinois development work was done, and the statistics for these are shown in the following statement:

Development work: 1902.

Number of mines	2
Number of operators	2
Wage-earners:	
Average number	5
Wages	$2,125
Cost of supplies and materials	$2,800
Miscellaneous expenses	$25

The 22 productive mines were controlled by 18 operators—2 individuals, 2 firms, and 14 incorporated companies.

Capital stock of incorporated companies.—The details of the capital stock and funded debt authorized and issued by the 14 incorporated companies are shown by states in Table 2.

Table 2.—*Capitalization of incorporated companies: 1902.*

	United States.	Illinois.	Kentucky.	All other states.[1]
Number of incorporated companies	14	3	9	2
Capital stock and bonds issued	$2,214,000	$1,536,000	$628,000	$50,000
Capital stock (all common)				
Total authorized—				
Number of shares	3,146,730	2,500,000	606,630	40,100
Par value	$3,813,000	$2,500,000	$1,263,000	$50,000
Total issued—				
Number of shares	1,726,320	1,536,000	150,220	40,100
Par value	$2,154,000	$1,536,000	$568,000	$50,000
Bonds:				
Authorized—				
Number	1,000	....	1,000	....
Par value	$100,000	....	$100,000	....
Issued—				
Number	600	....	600	....
Par value	$60,000	....	$60,000	....

[1] Includes companies distributed as follows: Arizona, 1; Tennessee, 1.

The 9 Kentucky companies issued capital stock to the amount of $568,000 and bonds to the amount of $60,000, making a total of $628,000, which is equivalent to 28.4 per cent of the total capitalization of all companies. The 3 companies in Illinois issued $1,536,000 of capital stock, representing 69.4 of the total capitalization. No dividends were reported on any of the stock and no interest was paid on the bonds.

Employees and wages.—The salaried employees numbered 42, or 13.5 per cent of the 311 salaried employees and wage-earners, and their salaries were $27,311, or 19.9 per cent of the total salaries and wages, which amounted to $137,313. The 269 wage-earners, therefore, constituted 86.5 per cent of the total number of employees, and their wages 80.1 per cent of the total salaries and wages.

As shown in Table 4, the busiest months in this industry, all states combined, were from May to December, inclusive. In Illinois, the largest number was employed in August; in Kentucky the maximum was not reached until October, which was true also of "all other states." The average number of wage-earners, at specified daily rates of pay for the different occupations is shown in Table 4. The majority of the miners received from $1.25 to $1.49 per day, 100 miners, or 56.8 per cent of the total number, receiving wages within these limits. For 35 miners, or 19.9 per cent of the total number, the wages were lower, being between $1 and $1.24 per day, while for 41 miners, or 23.3 per cent of the total number, they were higher, 32 miners receiving between $1.50 and $1.74, 5 between $1.75 and $1.99, and 4 between $2 and $2.24. Of the 16 engineers reported in the industry, 14 received between $1.50 and $1.74, and 2 received between $2.50 and $2.74. The rates paid machinists and engineers were, on the whole, higher than those for other wage-earners. The employees at the higher rates, included under "all other wage-earners," are men who wash or jig the ore.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials amounted to $31,374, and the miscellaneous expenses were $23,602. The amount included in the latter item for payment of royalties and rent of mines and mining plants was $7,900, or 33.5 per cent of the total; the balance, $15,702, or 66.5 per cent, was paid for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—At the 22 mines, primary power was employed aggregating 669 horsepower, of which 530 or 79.2 per cent was steam, and 139 or 20.8 per cent, gas or gasoline. There was, in addition, one electric motor, with a capacity of 25 horsepower.

Production.—The following table shows the quantity and value of fluorspar produced and sold since 1882:

TABLE 3.—*Production of fluorspar: 1882 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	Quantity (short tons).	Value.	Average value.	YEAR.	Quantity (short tons).	Value.	Average value.
1882	4,000	$20,000	$5.00	1893	12,400	$84,000	$6.77
1883	4,000	20,000	5.00	1894	7,500	47,500	6.33
1884	4,000	20,000	5.00	1895	4,000	24,000	6.00
1885	5,000	22,500	4.50	1896	6,500	52,000	8.00
1886	5,000	22,000	4.40	1897	5,062	37,159	7.34
1887	5,000	20,000	4.00	1898	7,675	63,050	8.21
1888	6,000	30,000	5.00	1899	15,900	96,650	6.08
1889	9,500	45,835	4.83	1900	18,450	94,500	5.12
1890	8,250	55,328	6.71	1901	19,586	113,803	5.81
1891	10,044	78,330	7.80	1902	48,018	271,832	5.66
1892	12,250	89,000	7.27				

From 1882 up to 1887, the annual production of fluorspar was only 4,000 or 5,000 tons. In the next few years the production increased considerably, reaching 12,400 tons in 1893. Then it fell off to 7,500 tons in 1894 and to 4,000 tons in 1895, thus reaching the figure at which it stood in the years 1882 to 1884. The year 1896 marked the beginning of a second period of increasing production, which appears to be still in progress. In 1899 the production was 15,900 tons, which was more than double that of the preceding year. But the most remarkable increase was in the year 1902, when the quantity produced showed a gain of 28,432 tons, or 145.2 per cent over that of the preceding year, and the value of the product, a gain of $158,029, or 138.9 per cent.

The average value of fluorspar per ton has varied from $4 to $8. The average was exceptionally high in the years 1896 to 1898, inclusive, reaching $8.21 in 1898. In 1902 it was $5.66; the prices reported for that year varied from $2.86 to $11.50 per ton, this higher value being obtained for the fluorspar mined in Arizona, which was used in California. This increase is due to fluorspar being much more largely used than formerly in the fluxing of iron in steel works, and as it is introduced into the smelting of copper and the reduction of other metals, there should be a still further increase in its production.

The imports of fluorspar are not separately stated in the records of the Bureau of Statistics of the Department of Commerce and Labor, but are included with minerals and oils not elsewhere specified.

The detailed statistics of the fluorspar industry for 1902 are shown in Table 4.

DESCRIPTIVE.

Occurrence and use.—Fluorspar is the common name of fluoride of calcium, a mineral occurring in crystals and masses of various colors, very commonly as the gangue of many metallic ores, especially of lead. It is found chiefly in veins in limestone, sandstone, mica slate, clay slate, and gneiss. When it occurs in commercial quantity, it is usually in cleavable masses, and of white, greenish white, or pale green color; but when small openings exist in the veins, the fluorspar is apt to be found in well-developed cubical crystals, which are generally highly colored with various tints of purple, indicating that it is associated with metallic minerals.

Until 1898 the only sources of fluorspar in the United States were the mines in Hardin and Pope counties, in southern Illinois, but during that year deposits were opened in Livingston and Crittenden counties, Ky., and in 1900 in Smith, Trousdale, and Wilson counties, Tenn., and in Yuma county, Ariz. As has been shown above, all these states were producers of fluorspar in commercial quantity in 1902. The mineral has been found widely distributed throughout the United States, but thus far it is only in the four states mentioned that it has been found in sufficient quantity for commercial purposes.

In the fluorspar deposits of Illinois and Kentucky there is known to be a very large supply of this mineral, capable of meeting the demand for many years.

As this overcomes one of the objections often advanced against using fluorspar in the smelting of iron, namely, that a constant supply of this mineral could not be depended upon, its use for this purpose should now increase rapidly. Other hindrances to the use of fluorspar for fluxing purposes have been the higher cost of this flux as compared with limestone, inaccessibility of the deposits, and the action of the slag and gases on the lining of the furnaces. But the recently discovered deposits of Kentucky and Tennessee, together with the deposits in Illinois, furnish an abundant supply, favorably located for transportation, either by railroad or water. The use of chromite (chromic iron ore), either in mineral form or as chrome bricks, will make a lining for furnaces which can be affected but little by the use of fluorspar as a flux. Fluorspar possesses qualities that make it especially adapted for the fluxing of iron, and these should more than compensate for its higher cost, as compared with limestone. Thus far the larger proportion of the fluorspar mined has been used in steel works. Very little is used in blast furnaces or in the smelting of copper or other metals; for these purposes, and also in foundry work, its use will undoubtedly increase rapidly when its value as a flux is more thoroughly understood.

Another use of fluorspar, and formerly its chief use, is in the preparation of hydrofluoric acid. At the present time it is estimated that only from 5 to 10 per cent of the product is used for this purpose. The mineral is also used in the manufacture of opalescent glass, being considered very essential for this purpose.

TABLE 4.—DETAILED SUMMARY: 1902.

	United States.	Illinois.	Kentucky.	All other states and territories.[1]
Number of mines	22	5	14	3
Number of operators	18	5	10	3
Character of ownership:				
Individual	2	1		1
Firm	2	1	1	
Incorporated company	14	3	9	2
Salaried officials, clerks, etc.:				
Total number	42	9	31	2
Total salaries	$27,311	$5,304	$21,107	$900
General officers—				
Number	12	1	11	
Salaries	$11,545	$300	$11,245	
Superintendents, managers, foremen, surveyors, etc.—				
Number	17	3	12	2
Salaries	$12,437	$3,500	$8,037	$900
Foremen, below ground—				
Number	11	3	8	
Salaries	$2,849	$1,024	$1,825	
Clerks—				
Number	2	2		
Salaries	$480	$480		
Wage-earners:				
Aggregate average number	269	71	193	5
Aggregate wages	$110,002	$28,845	$79,107	$2,050
Above ground—				
Total average number	140	38	98	4
Total wages	$56,235	$15,328	$39,407	$1,500
Engineers, firemen, and other mechanics—				
Average number	25	5	20	
Wages	$12,626	$2,481	$10,145	
Miners—				
Average number	56	4	48	4
Wages	$21,180	$1,275	$18,405	$1,500
Boys under 16 years—				
Average number	2		2	
Wages	$234		$234	
All other wage earners—				
Average number	57	29	28	
Wages	$22,195	$11,572	$10,623	
Below ground—				
Total average number	129	33	95	1
Total wages	$53,767	$13,517	$39,700	$550
Miners—				
Average number	120	24	95	1
Wages	$50,504	$10,254	$39,700	$550
Miners' helpers—				
Average number	9	9		
Wages	$3,263	$3,263		
Average number of wage-earners at specified daily rates of pay:				
Engineers—				
$1.50 to $1.74	14	2	12	
$2.50 to $2.74	2	1	1	
Firemen—				
$1.00 to $1.24	1		1	
$1.25 to $1.49	1	1		
$2.00 to $2.24	2		2	
Machinists, blacksmiths, carpenters, and other mechanics—				
$1.50 to $1.74	2	1	1	
$2.50 to $2.74	1		1	
$3.00 to $3.24	2		2	
Average number of wage-earners at specified daily rates of pay—Continued.				
Miners—				
$1.00 to $1.24	35	5	28	2
$1.25 to $1.49	100	12	88	
$1.50 to $1.74	32	7	25	
$1.75 to $1.99	5	1	2	2
$2.00 to $2.24	4	3		1
Miners' helpers—				
$1.00 to $1.24	1	1		
$1.25 to $1.49	8	8		
Boys under 16 years—				
$0.75 to $0.99	2		2	
All other wage-earners—				
$1.00 to $1.24	2	1	1	
$1.25 to $1.49	45	25	20	
$1.50 to $1.74	3		3	
$2.00 to $2.24	7	3	4	
Average number of wage-earners employed during each month:				
Men 16 years and over—				
January	161	58	103	
February	147	51	96	
March	147	49	98	
April	183	60	123	
May	255	66	186	3
June	280	67	210	3
July	333	88	243	2
August	340	89	243	8
September	354	86	250	10
October	375	83	280	12
November	336	76	249	11
December	296	80	202	14
Boys under 16 years—				
July	4		4	
August	4		4	
September	4		4	
October	4		4	
November	4		4	
December	4		4	
Contract work:				
Amount paid	$300		$300	
Number of employees	3		3	
Miscellaneous expenses:				
Total	$23,602	$1,149	$22,328	$125
Royalties and rent of mine and mining plant	$7,900	$250	$7,650	
Rent of offices, taxes, insurance, interest, and other sundries	$15,702	$899	$14,678	$125
Cost of supplies and materials	$31,974	$17,115	$13,952	$907
Product:				
Quantity, short tons	48,818	18,860	29,030	928
Value	$275,682	$123,000	$143,410	$9,272
Power owned:				
Total horsepower	669	162	507	
Engines—				
Steam—				
Number	17	6	11	
Horsepower	530	162	368	
Gas or gasoline—				
Number	10		10	
Horsepower	139		139	
Electric motors—				
Number	1		1	
Horsepower	25		25	

[1] Includes operators distributed as follows: Arizona, 2; Tennessee, 1.

GYPSUM

GYPSUM.

By Story B. Ladd.

The statistics presented herewith comprise those for gypsum in its calcined form as well as in its natural state. The chief consumption of gypsum is for the manufacture of plaster of Paris and wall or cement plaster, of which plaster of Paris is the chief ingredient. At the Tenth Census no statistics in regard to gypsum were reported, and at the three decades prior thereto, namely, 1870, 1860, and 1850, only the manufacturing statistics for plaster are available for purposes of comparison. Table 1 is a comparative summary for the years 1850, 1860, 1870, 1889, and 1902.

Table 1.—*Comparative summary: 1850 to 1902.*

	1902	1889	1870	1860	1850
Number of mines or quarries	62	(1)	(1)	(1)	(1)
Number of operators	45	(1)	[2]321	[2]307	[2]140
Salaried officials, clerks, etc.:					
Number	219	(3)	(3)	(3)	(3)
Salaries	$300,420	(3)	(3)	(3)	(3)
Wage-earners:					
Average number	1,472	761	1,513	866	381
Wages	$759,258	$249,290	$533,407	$232,500	$100,692
Contract work	$406	$10,031	(1)	(1)	(1)
Miscellaneous expenses	$200,769	$45,292	(1)	(1)	(1)
Cost of supplies and materials	$941,760	$128,854	$1,430,110	$522,896	$239,093
Product[4]:					
Quantity, short tons	681,633	246,725	(1)	(1)	(1)
Value	$2,089,341	$764,118	$2,691,851	$1,110,854	$428,914

[1] Not reported.

[2] Establishments.

[3] Not reported separately.

[4] The United States Geological Survey reports 816,478 short tons of crude gypsum, of the value as here given. The Census figures of quantity are for the product prepared, in greatest part, for the market.

In 1850 the value of the land-plaster product was given as $428,914. In 1860 the value of plaster and its manufactures was $1,110,854, and presumably the largest portion of this amount was land plaster. In 1870 the amount of plaster manufactured, reported as "Plaster, ground," and presumably chiefly used for land plaster, reached $2,691,851. Up to this time there appears to have been a steady growth in the use of gypsum as a fertilizer, but with the development of the phosphate rock industry, which began just prior to the close of the decade ending in 1870, came a corresponding reduction in the use of gypsum for land plaster, and in 1880 the total gypsum production, as reported by the United States Geological Survey, was but 90,000 short tons, valued at $400,000.

The mining of phosphate rock commenced in South Carolina in 1867, and in 1870 the production was 65,241 long tons. In 1880 the sales of phosphate rock in the United States amounted to 211,377 long tons, valued at $1,123,823, while the gypsum product had fallen, as above noted, to a value of $400,000. In 1889 the sales of phosphate rock were 550,245 long tons, valued at $2,937,776. Florida had lately become a producer. On the other hand, the ground gypsum sold as land plaster in 1889 was but 108,771 short tons, valued at $233,307, in contrast with the production for 1870 of ground plaster, valued at $2,691,851.

The shrinkage in the consumption of gypsum for land plaster continues, the growth in the gypsum industry since 1889 being due to the increasing use of wall or cement plaster. In 1889, 108,771 tons, or 40.6 per cent, of the gypsum was sold as land plaster; in 1902 only 60,791 tons, or 7.4 per cent.

The growth of the industry during the period 1889 to 1902 has been entirely in the production of calcined gypsum. In 1889, 85,755 tons of gypsum, or 32 per cent of the amount quarried, were calcined, while in 1902 the quantity calcined was 674,232 tons, or 82.6 per cent of the gypsum quarried, producing 539,387 tons of calcined plaster products—plaster of Paris and wall or cement plaster. Along with the increased consumption of calcined plaster there was a decrease in the average price from $6.92 per ton in 1889 to $3.50 per ton in 1902. There was no material change in the average price of crude gypsum, it being $1.13 per ton in 1889 and $1.15 per ton in 1902. The average value of the land plaster, however, decreased from $2.14 per ton in 1889 to $1.75 per ton in 1902.

A change in the character of the industry is also shown by the reduction in the number of operators. In 1870, 321 operators were reported, and in 1902 only 45. The number of mines, which in 1870 must have been at least 321—that being the number of operators—was only 62 in 1902. The production of land plaster requires small capital, the gypsum being simply mined or quarried and ground; and the average values of the product per operator for the years 1850, 1860, and 1870—$3,064, $3,910, and $8,386, respectively—indicates that during that earlier period, when land plaster was the principal or sole product, this industry was small and local in character. The statistics for 1902 show a concentration of the business. The 62 producing mines or quarries were controlled by 45 operators and the average value of the product per operator was $46,430. Of the 62 active mines or quarries, 19 were operated by 2 companies. The reduction in the number of operators and active mines or quarries reflects the growth of the wall plaster industry, which has a wider market and requires a much larger capital and plant than the mere manufacture of land plaster.

During the period from 1889 to 1902, the value of the product increased 173.4 per cent, the wage-earners 93.4 per cent, and the amount paid in wages 204.7 per cent.

There were 17 idle mines or quarries in 1902, distributed as follows: 8 in New York, 3 in Arizona, and 1 each in Kansas, Missouri, New Mexico, Ohio, Texas, and Virginia. These were owned by 9 individuals, 1 firm, and 5 incorporated companies. Two of the mines in Arizona were owned by 1 individual. Two of the other idle mines, 1 in Kansas and 1 in Missouri, were owned by 1 corporation, which operated 16 active mines or quarries in Iowa, Kansas, Michigan, New York, Ohio, and Oklahoma. The statistics of the capitalization of this corporation are included among those of the active mines. The remaining 4 incorporated companies were located 1 each in New York, New Mexico, Ohio, and Texas. Three of these did not report capitalization. The fourth company reported an authorized capital stock of 250,000 shares, with a par value of $250,000; all of the common stock, 200,000 shares of a par value of $200,000, had been issued. It reported also authorized bonds of a par value of $25,000, of which $15,000 had been issued, making a total of $215,000 for stocks and bonds issued.

Of the 45 operators in 1902, 13 were individuals, 6 were firms, and 26 were incorporated companies. Only 3.6 per cent of the gypsum mined or quarried was produced by the 19 individuals and firms, and in Iowa, Kansas, Michigan, Oklahoma, Texas, and Utah the operators were solely incorporated companies.

Capital stock of incorporated companies.—Table 2 presents the details of the capitalization of the incorporated companies.

TABLE 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Kansas.	Michigan.	New York.	Oklahoma.	All other states.
Number of incorporated companies	26	5	[1]4	6	3	[2]8
Number reporting capitalization	25	5	4	6	3	7
Capital stock and bonds issued	$10,670,965	$245,765	$8,157,500	$659,800	$260,000	$1,347,900
Capital stock:						
Total authorized—						
Number of shares	106,880	1,821	83,100	5,540	2,600	13,819
Par value	$10,576,665	$220,765	$8,160,000	$551,000	$260,000	$1,384,900
Total issued—						
Number of shares	106,298	1,821	83,000	5,398	2,600	13,479
Par value	$10,525,965	$220,765	$8,157,500	$539,800	$260,000	$1,347,900
Dividends paid	$64,300	$3,126	$35,700		$2,400	$23,074
Common—						
Authorized—						
Number of shares	61,580	1,821	38,100	5,240	2,600	13,819
Par value	$6,046,665	$220,765	$3,660,000	$521,000	$260,000	$1,384,900
Issued—						
Number of shares	60,998	1,821	38,000	5,098	2,600	13,479
Par value	$5,995,965	$220,765	$3,657,500	$509,800	$260,000	$1,347,900
Dividends paid	$64,300	$3,126	$35,700		$2,400	$23,074
Preferred—						
Authorized—						
Number of shares	45,300		45,000	300		
Par value	$4,530,000		$4,500,000	$30,000		
Issued—						
Number of shares	45,300		45,000	300		
Par value	$4,530,000		$4,500,000	$30,000		
Bonds:						
Authorized—						
Number	1,645	25	1,500	120		
Par value	$1,145,000	$25,000	$1,000,000	$120,000		
Issued—						
Number	145	25		120		
Par value	$145,000	$25,000		$120,000		
Interest paid	$2,700	$1,500		$1,200		
Assessments levied	$3,240			$3,240		

[1] One of these companies operated mines and quarries in Iowa, Kansas, New York, Ohio, and Oklahoma, as well as in Michigan.

[2] Includes companies distributed as follows: Iowa, 3; Texas, 2 (1 company operating quarries also in Oklahoma and Wyoming); Utah, 1; Virginia, 1; Wyoming, 1.

Of the 26 incorporated companies, 6 were in New York, 5 in Kansas, 4 in Michigan, 3 each in Iowa and Oklahoma, 2 in Texas, and 1 each in Utah, Virginia, and Wyoming. These companies operated 43 mines or quarries distributed as follows: 9 in Iowa, 8 in New York, 7 in Kansas, 6 in Michigan, 5 in Oklahoma, 2 each in Ohio, Texas, and Wyoming, and 1 each in Utah and Virginia. The capitalization was reported for all of the incorporated companies, with the exception of 1 company in Iowa not engaged exclusively in the mining or quarrying of gypsum and the manufacture of its products. The authorized capital stock consisted of 61,580 shares of common stock of a par value of $6,046,665, and 45,300 shares of preferred stock of a par value of $4,530,000; at the close of the year covered by this investigation, 60,998 shares of common stock of a par value of $5,995,965, and all of the preferred stock had been issued. The authorized bonded indebtedness comprised 1,645 bonds of a par value of $1,145,000, of which there had been issued 145 bonds of a par value of $145,000. The outstanding capital stock and bonds issued aggregated $10,670,965.

The interest paid on the bonded debt was $2,700; the small amount is explained by the fact that the organization of several of the companies occurred during 1902, and only 2 companies reported the payment of interest on bonds aggregating $45,000. Dividends amounting to $64,300 were paid by 6 companies, distributed 1 each in Iowa, Kansas, Michigan, Oklahoma, Texas, and Utah. The capitalization of 1 company operating mines or quarries in Iowa, Kansas, Michigan, New York, Ohio, and Oklahoma was credited to Michigan, as its largest production was from that state; and, in like manner, the capitalization of 1 company operating mines or quarries in Oklahoma, Texas, and Wyoming was credited to Texas, where its largest plant was located.

Employees and wages.—Of the total amount, $1,059,678, reported as paid for salaries and wages, $759,258, or 71.6 per cent, was paid to the wage-earners, and $300,420, or 28.4 per cent, to the salaried employees.

The variation in the number of wage-earners employed at different seasons of the year is shown in Table 6, which gives the average number of men and boys employed during each month. The employment of boys under 16 is reported only in the case of 1 mine. The least average number of wage-earners employed during any month was 773 in January, and the largest average number for any month was 1,696 in September. For the remaining months the number fluctuated within a comparatively narrow range. The number of wage-earners employed at specified daily rates of pay is also shown in Table 6.

The prevailing rate of pay for wage-earners was from $1.50 to $1.74 per day, 754, or 51.2 per cent, receiving this rate. The per cent receiving less than $1.25 per day was only 2.5; 5.6 per cent received from $1.25 to $1.49; 23 per cent, from $1.75 to $1.99; 10.2 per cent, from $2 to $2.24; 3.3 per cent, from $2.25 to $2.49; 2.5 per cent, from $2.50 to $2.74; and 1.7 per cent received $3 and over. Of the total number of wage-earners 614, or 41.7 per cent, were classed as miners or quarrymen. Of these 329, or 22.4 per cent, received from $1.50 to $1.74 per day. Nine received from $3 to $3.24 per day.

Mining and quarrying on a tonnage basis was reported by 18 mines or quarries, at rates ranging from a minimum of $0.20 per ton to a maximum of $0.65 per ton, with an average of $0.445 per ton. These mines or quarries were distributed as follows: 7 in Iowa, 4 in New York, 2 in Kansas, and 1 each in California, Michigan, Oklahoma, Texas, and Utah.

Supplies, materials, and miscellaneous expenses.—The total amount reported for supplies and materials was $341,760. In the case of operators producing uncalcined gypsum only, either crude gypsum or land plaster, the expense for supplies and materials was small, only 5 or 10 cents per ton.

The total amount reported for miscellaneous expenses was $200,769, of which amount $49,912 was paid by 20 mines or quarries for royalties and rent of mine and mining plant; and $150,857 for rent of offices, taxes, insurance, interest, and other sundries. The mines or quarries reporting the payment of royalties and rent of mine and mining plant were distributed as follows: Six in New York, 4 in Kansas, 2 each in Iowa, Ohio, Oklahoma, and Wyoming, and 1 each in Texas and Virginia.

Mechanical power.—Of the 62 mines or quarries operated, 55 reported power, the primary power employed aggregating 7,319 horsepower. Where mills were operated in conjunction with the mine or quarry, this includes mill power as well as power directly employed in mining or quarrying. The power was supplied by 68 steam engines, aggregating 6,385 horsepower; 2 gas or gasoline engines with a total of 20 horsepower; and 11 water wheels having 914 horsepower. There were, in addition, 5 electric motors with a capacity of 68 horsepower.

Production.—The total production for the year 1902 was 816,478 short tons of gypsum quarried, of which 674,232 tons were calcined, producing 539,387 tons of calcined plaster—plaster of Paris and wall or cement plaster—valued at $1,889,190. There were sold in the crude state 81,455 tons of gypsum, valued at $93,914, an average price of $1.15 per ton; and 60,791 tons ground for land plaster, valued at $106,237, an average price of $1.75 per ton. The 539,387 tons of calcined products comprised 188,702 tons of plaster of Paris, valued at $562,928, an average price of $2.98 per ton; and 350,685 tons of wall or cement plaster, valued at $1,326,262, an average price of $3.78 per ton. The production of the 188,702 tons sold as plaster of Paris consumed 235,878 tons of crude gypsum; and the production of the 350,685 tons of wall or cement plaster consumed 438,354 tons of gypsum before calcination into plaster of Paris and manufacture into wall or cement plaster. The increase in the marketable gypsum products for 1902 over those of 1889 was in quantity 434,908 tons, or 63.7 per cent, and in value $1,325,223, or 173.4 per cent.

Of the calcined products 65.3 per cent was wall or cement plaster, including all of the calcined product from the states of Nevada, South Dakota, and Utah; 90 per cent and over of that from California, Kansas, Montana, Oklahoma, Texas, and Wyoming; from 80 to 90 per cent of that from Iowa and Oregon; 60 per cent of that from Colorado, and less than 50 per cent only from Michigan, New York, Ohio, and Virginia.

Table 3 shows the production of gypsum in the United States from 1880 to 1902, as reported by the United States Geological Survey.

TABLE 3.—*Production of gypsum: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1901 and 1902.]

YEAR.	Quantity of gypsum (short tons).	Value of products; crude, land plaster, and calcined.	YEAR.	Quantity of gypsum (short tons).	Value of products, crude, land plaster, and calcined.
1880	90,000	$400,000	1892	256,259	$695,492
1881	85,000	350,000	1893	253,615	696,615
1882	100,000	450,000	1894	239,312	761,719
1883	90,000	420,000	1895	265,503	797,447
1884	90,000	390,000	1896	224,254	573,344
1885	90,405	405,000	1897	288,982	755,864
1886	95,250	428,625	1898	291,638	755,280
1887	95,000	425,000	1899	486,235	1,287,080
1888	110,000	550,000	1900	594,462	1,627,203
1889	[1] 267,769	764,118	1901	633,791	1,506,641
1890	182,995	574,523	1902	[2] 816,478	2,089,342
1891	208,126	628,051			

[1] Marketable products 246,725 short tons.

[2] Marketable products 681,633 short tons.

Beginning with the year 1899 there was shown a marked annual increase in the quantity of gypsum produced. The increase in 1899 was 66.7 per cent; in 1900, 22.3 per cent; in 1901, 12 per cent; and 1902, 24 per cent. The total increase from 1898 to 1902 was 524,840 tons, or 180 per cent.

The imports of gypsum from 1889 to 1902 are shown in the following table:

TABLE 4.—*Gypsum imported into the United States: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING—	GROUND OR CALCINED.		UNGROUND.		Value of manufactured plaster of Paris.	Total value.
	Quantity (long tons).	Value.	Quantity (long tons).	Value.		
December 31—						
1889	5,466	$40,291	170,965	$179,849	(1)	$220,140
1890	7,568	55,250	171,289	174,609	(1)	229,859
1891	9,560	27,316	110,257	129,003	(1)	156,319
1892	6,842	75,608	181,104	242,403	(1)	318,011
1893	3,863	31,670	164,300	180,254	(1)	211,924
1894	2,027	16,853	162,500	179,257	(1)	196,110
1895	3,585	21,526	192,549	215,705	$10,352	247,583
1896	3,282	21,982	180,269	193,544	11,722	227,248
1897	2,064	17,098	163,201	178,686	16,715	212,499
1898	2,073	18,501	166,066	181,364	40,979	240,844
1899	3,585	19,250	196,579	220,548	58,173	297,971
1900	5,109	19,179	209,881	229,878	66,473	315,530
1901	5,106	19,627	235,204	238,140	68,903	326,670
1902	3,647	23,225	305,367	284,942	52,533	360,700

[1] Not specified.

The world's production of gypsum from 1893 to 1902, inclusive, is shown in the following table:

TABLE 5.—THE WORLD'S PRODUCTION OF GYPSUM: 1893 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	UNITED STATES.		FRANCE.		CANADA.		GREAT BRITAIN.		GERMAN EMPIRE.		ALGERIA.		INDIA.		CYPRUS.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1893	253,615	$696,615	....	....	192,568	$196,150	158,122	$267,940	....	....	....	....	....	....	2,337	$6,625
1894	239,312	761,719	1,093,831	$2,891,365	223,631	202,031	169,102	321,822	....	....	36,355	$111,900	3,548	$1,566	3,104	9,006
1895	265,503	797,447	2,175,148	3,392,768	226,178	202,608	196,037	348,400	23,994	$11,040	50,127	133,228	7,511	2,987	2,033	5,252
1896	224,254	573,344	1,966,898	2,661,200	207,032	178,061	213,028	361,609	31,756	14,598	41,370	114,361	8,248	3,130	1,040	2,590
1897	288,982	755,864	1,845,874	2,673,033	239,691	244,531	301,151	325,513	28,821	13,228	60,510	109,648	9,025	3,185	1,167	8,162
1898	291,638	755,280	1,931,712	2,777,816	219,256	230,440	219,549	315,882	28,315	13,166	41,156	110,660	9,249	1,503	1,279	7,551
1899	486,235	1,287,080	1,902,812	2,641,020	244,566	257,329	238,071	372,073	32,700	19,660	44,037	117,895	7,216	768	1,102	8,806
1900	594,462	1,627,203	1,761,835	2,772,221	252,001	259,009	233,002	348,210	39,103	17,199	41,146	139,190	4,985	424	....	....
1901	633,791	1,506,641	2,182,229	3,449,747	293,979	340,148	224,919	344,050	[1] 35,013	[1] 23,139	38,955	132,286	(2)	(2)	....	....
1902	816,478	2,089,341	(2)	(2)	332,045	356,317	251,615	(2)	(2)	(2)	(2)	(2)	(2)	(2)	....	....

[1] Includes Baden.

[2] Not yet available.

The detailed statistics for the gypsum industry during 1902 are given in Table 6.

DESCRIPTIVE.

Gypsum, a natural product, is calcium sulphate, of the chemical formula $CaSO_4.2H_2O$, containing 46.5 per cent of sulphuric acid, 32.6 per cent of lime, and 20.9 per cent of water. Anhydrite, a mineral like gypsum, but, as its name indicates, containing no water, is composed of 58.8 per cent of sulphuric acid and 41.2 per cent of lime. This absorbs water and changes to gypsum. When gypsum is properly calcined it loses a part of the water of its composition and becomes plaster of Paris, the name originating from the great deposits of gypsum worked at Montmartre, a suburb of Paris. The transparent crystallized variety of gypsum is called selenite; its fine massive variety, alabaster; and its fibrous form, satin spar. A loose earthy gypsum found in Kansas and other points in the West is called gypsite.

Gypsum crystallizes in the monoclinic system, has a hardness of 2, and a specific gravity of 2.31. Its color is usually white, although sometimes red, green, blue, gray, or brown. When protected from the action of water it is extremely durable, as evidenced by the numerous monumental effigies, many centuries old, in European churches and elsewhere.

It is quite generally distributed and occurs in irregular and often in very extensive and massive deposits. A deposit of white crystalline gypsum at Netherfield, England, is more than 50 feet in thickness, and in the Thüringerwald, Germany, a great mass has been sunk through to a depth of 70 feet. The gypsum deposits of Onondaga county, N. Y., show in places a thickness of 60 feet. The snow-white alabaster found at Volterra, in Tuscany, Italy, is used extensively at Florence and Leghorn for works of art. It is white when newly broken and on drying becomes even whiter on the surface. It is easily cut and turned and under proper treatment takes a fine polish and satin luster.

Origin.—Gypsum deposits have been formed by direct deposition, and by the alteration of existing lime deposits. Most of the gypsum deposits of the world are considered to have been formed by the evaporation and concentration of sea water, although the calcium sulphate is not deposited until about 80 per cent of the water has been evaporated. Sea water, according to the analyses in the Challenger Reports, contains 3.5 per cent of mineral matter of the following constituents:

	Per cent.
Sodium chloride (salt)	77.758
Magnesium chloride	10.878
Magnesium sulphate	4.737
Calcium sulphate (gypsum)	3.600
Potassium sulphate	2.465
Calcium carbonate	0.345
Magnesium bromide	0.217
	100.000

When such a body of water cut off from the ocean is evaporated, the calcium sulphate is deposited before the sodium chloride, the latter being thrown down only after the removal of 93 per cent of the water. With complete evaporation and deposition there would be, therefore, first a deposit of gypsum and then a heavy deposit of salt, though the evaporation may go far enough to deposit the gypsum, but not far enough to deposit the salt; or if the latter be deposited it may be removed subsequently by solution. Gypsum deposits, therefore, are more widely spread than salt, but usually occur in thinner beds.

When sulphuric acid, liberated by the decomposition of pyrite, acts on calcium carbonate and converts it into calcium sulphate, there is generally a gradual transition from the limestone into the gypsum rock.

Gypsum is deposited by some thermal springs, as in Iceland, where the sulphurous acids on becoming oxidized change to sulphuric acid, which converts the calcium carbonate into calcium sulphate, and this when evaporation takes place is deposited in fibrous and crystalline forms.

The theory of Dawson on the origin of gypsum at Plaister Cove, Nova Scotia, is as follows: First, there was an accumulation of numerous thin layers of limestone, either so rapidly or at such great depths that organic remains were not included in any but the upper layers. Second, there was an introduction of sulphuric acid, in solution or in vapor, which was a product of volcanic action. Then for a long time the acid waters acted upon the calcareous material without interruption from mechanical detritus, changing the calcium carbonate to calcium sulphate, and gypsum of good quality accumulated in considerable thickness.

Occurrence.—Gypsum is widely distributed geologically, being found in various formations ranging from the Silurian up to the Tertiary. In New York extensive beds of gypsum are found in the Silurian formation; in Ohio and Michigan they occur in the Carboniferous; and in Iowa and Kansas they are Cretaceous.

Gypsum is also widely distributed geographically. In the United States it is found in Arizona, California, Colorado, Iowa, Kansas, Michigan, Montana, Nevada, New Mexico, New York, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, and Wyoming, and is mined in all these states except Arizona, Missouri, and New Mexico. It is found in Arabia, Austria, Bohemia, Canada, Egypt, England, France, Germany, Italy, Norway, and Persia.

Use.—The use of gypsum was known at a very early period, for the Greeks were familiar with it, as shown by the writings of Theophrastus and Pliny. Gypsum in its ground, uncalcined state is used chiefly for land plaster, a fertilizer. In its calcined form, as plaster of Paris, it has extensive and varied uses.

Land plaster.—Ground plaster has long been used as a fertilizer. Virgil wrote concerning the value of gypsum on cultivated lands. Benjamin Franklin called attention to the value of gypsum as a fertilizer for grass by sowing land plaster in a clover field, so as to form the sentence, "This has been plastered with gypsum," the letters showing by the height and color of the clover where gypsum had been sown.

Numerous experiments and tests are on record as to the value of gypsum as a fertilizer. Boussingault in 1841 fertilized a clover field with gypsum and analyzed the clover grown on fertilized and on unfertilized land. These experiments were conducted for two years on the same land, and the analyses of the ash of the clover from a hectare of ground showed as follows, in kilograms:

Analyses of clover.[1]

	1841		1842	
	Land with gypsum	Land without gypsum.	Land with gypsum.	Land without gypsum.
Ashes free from CO_2	270.0	113.0	280.0	97.0
Silica	28.1	22.7	10.4	12.7
Oxide (iron, manganese, alumina)	2.7	1.4	[illegible]	0.6
Lime	79.4	52.2	102.8	32.2
Magnesia	18.1	8.6	28.5	7.1
Potash	95.6	25.7	97.2	28.6
Soda	2.4	1.4	0.8	2.8
Sulphuric acid	9.2	4.4	9.0	3.0
Phosphoric acid	21.2	11.0	22.9	7.0
Chlorine	10.3	4.6	8.4	3.0

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[1] The University Geological Survey of Kansas, Vol. V, Report on Gypsum and Gypsum Cement Plasters.

This shows an increase in all the mineral constituents, but especially in lime, magnesia, and potash.

The theories of the action of gypsum as a fertilizer have been many. Sir Humphry Davy and others before and after his time have regarded gypsum as a direct source of plant food. It is now thought that gypsum acts as a fertilizer in three ways, one, mechanical and two chemical:

(1) The gypsum by mechanical action flocculates loose soils.

(2) Gypsum as pointed out by Storer[1] has nearly one-half its weight in oxygen and gives this up to many substances, and so may act upon nitrogenous and carboniferous substances in the soil.

(3) Gypsum decomposes the double silicates in the earth, setting free potash as a soluble silicate. According to Storer, the action is as follows:

$$\left.\begin{matrix}Al_2O_3\\CaO\\K_2O\\H_2O\end{matrix}\right\}XSiO_2 + CaOSO_2 = \left\{\begin{matrix}Al_2O_3\\CaO\\CaO\\H_2O\end{matrix}\right\}XSiO_2 + K_2OSO_3$$

By this means the potash in solution reaches the roots of the plants. Soils with abundant potash do not need land plaster, and soils with no potash compounds are not benefited in this respect by it.

Plaster of Paris.—The phenomena attendant upon the baking and hardening of plaster of Paris were first studied by Lavoisier. In the Comptes Rendus of February 17, 1765, appears the following: "After having removed the water of hydration from gypsum by heat, if it be presented to it again (this is commonly known as the mixing or tempering of plaster), it takes it back with avidity, and suddenly assumes a state of irregular crystallization; the small crystals which form become confused with each other, the result being a very hard mass." Lavoisier discovered that when plaster was baked at too high a temperature it lost its peculiar property of setting, and that when it was heated the water of crystallization was removed at two different stages, three-fourths of it being much more easily removed than the remainder. Payen, in 1830, found that gypsum began to lose its water of crystallization at 115° C., and that the loss increased rapidly as the temperature rose. He concluded that a temperature of from 110° to 120° C. was the best for calcination, but that plaster of Paris could be made at a lower temperature, even as low as 80° C., if the burning were continued long enough. He found that gypsum was dehydrated if heated to about 250° C., and from 300° to 400° C. it lost completely the properties of hydration.

Le Chatelier experimented in 1887 on the effects of temperature on gypsum. On heating gypsum to 200° C., he found that there was a constant rise in temperature, with two breaks; the first halt at 128° C. and the second at 163° C., indicating the existence of two different hydrates, whose decomposition took place at the temperatures stated. The dehydration was found to be incomplete at 155° C. and complete at 194° C.

An analysis of the first hydrate gave:

	Per cent.
Water	6.7
Calcium sulphate	93.3
	100.0

This agrees very closely with the formula $(CaSO_4)_2H_2O$, which gives:

	Per cent.
Water	6.2
Calcium sulphate	93.8
	100.0

Gypsum has 1 part of calcium sulphate united with 2 parts of water, while this hydrate shows 2 parts of calcium sulphate united with 1 part of water. The same hydrate is found in the incrustation of the boilers of ocean steamers when fed with sea water, as shown by the following analysis:

Analysis of boiler incrustation from a trans-Atlantic steamer.

	Per cent.
Calcium carbonate	0.3
Ferric oxide	2.0
Water	5.8
Calcium sulphate	91.9
	100.0

The temperature at which this compound is completely dehydrated lies between 160° and 170° C. Broken up and mixed with water, it hydrates and hardens. Further experiments showed plaster of Paris to be a definite hydrate with the formula $(CaSO_4)_2H_2O$.

The second halt noticed in Le Chatelier's experiments took place at 163° C., and from this temperature to 221° C. no change was noted in the plaster, but beyond 221° C. the plaster, when mixed with water, did not absorb it readily and set only after a long time. If the heat reaches 343° C., the plaster acts like an anhydrite and is said to be "dead burned." It will not set on the addition of water. When heated still more the substance melts and, on cooling, forms a crystalline mass, which can not be decomposed by heat, except in the presence of organic matter, when it changes into CaS. If this substance is acted upon by carbon dioxide gas (CO_2) and water, sulphureted hydrogen gas is formed.

The burning of gypsum is, therefore, a very important matter, and calciners become very expert. If the gypsum is underburned, the new hydrate is not formed, and the plaster will not set. If it is overburned, the plaster sets very slowly.

Lavoisier gave the following account of his theory of set in plaster:

> I took the calcined plaster, which hardens readily with water, and threw it into a considerable amount of water. Each molecule of plaster, in passing through the liquid, seized its molecule of water of crystallization and fell to the bottom in the form of small brilliant needles, visible only with a strong lens. These needles, dried in the open air or with the aid of a moderate heat, are very

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[1] Chemistry of Agriculture, Vol. I, 1887, pages 206 to 216.

> soft and silky to the touch. Under a microscope it is perceived that what was taken under the lens for needles are also parallelopipeds, very fine, some thicker, many thinner, and many more elongated. The plaster in this state is not capable of uniting with water, but if it is calcined anew these small crystals lose their transparency and their water of crystallization and become again a true plaster, as perfect as before. One may, in this fashion, successfully calcine and recrystallize the plaster, even to infinity, and consequently give to it at will the property of seizing water.

Landrin, who, in a paper published in 1874,[1] quoted the above, and gave the results of a study of plaster, divided the set of plaster into four periods as follows:

(1) The calcined plaster, on contact with water, unites with this liquid and takes a crystalline form.

(2) The plaster dissolves partially in the water, which becomes saturated with this salt.

(3) A part of this liquid evaporates, due to the heat set free in the chemical combination. A crystal is formed and determines the crystallization of the entire mass, a phenomenon which is analogous to that which takes place when a piece of sodium sulphate is placed in a saturated solution of this salt.

(4) The maximum hardness is reached when the plaster loses enough water to correspond exactly to the formula $(CaSO_4)_2H_2O$, this maximum being to the remainder in proportion to the quantity of water added to the plaster to transform it into mortar.

The maximum hardness then was reached when the plaster contained about 20 per cent of water. Landrin believed that the loss of water was due to the evaporation.

Le Chatelier showed that plaster would set in a vacuum, so that evaporation was not a necessary step. According to Le Chatelier, the plaster of Paris dissolves, becomes hydrated, and then crystallizes out as gypsum, and every particle of the plaster goes through these steps.

Microscopic examination[2] shows that ground gypsum, before calcination, is composed of rather large masses of various sizes, these masses consisting of more or less broken crystals. After calcination these larger masses are broken up into fine granules nearly uniform in size and shape. As the material is heated, the water is changed into steam and, expanding, breaks the crystals into finer particles. There is thus a physical change, as well as a chemical one.

When water is added to the calcined plaster, small needle-like crystals are seen forming and shooting out here and there, and these, as they become more abundant, unite and form a solid mass, in which the individual crystals can scarcely be distinguished. Open spaces left in the mass are finally closed and a firm solid mass results.

Uncalcined gypsum treated with water shows, under the microscope, very little change. Gypsum crystallized by evaporation shows crystals which are not needle-shaped, but broader and of considerable irregularity. They do not interpenetrate, but form a loose mass which readily crumbles.

Crystallization is aided by the small size of the grains, and the finer-grained plasters set more rapidly than the coarser-grained ones, as shown by the comparison of the fine dental plasters with ordinary plaster of Paris.

Manufacture. In the manufacture of plaster of Paris the gypsum rock is crushed and ground into flour in a buhr mill, a roller mill, or a disintegrator. The ground gypsum is then passed into storage bins. In some mills the flour gypsum is conveyed to the bins by an air blast.

The calcining kettles are made of boiler steel and hold about 8 tons; the flame is carried around the sides, by flues, so as to heat all parts. In charging, the ground gypsum is run slowly into the kettle, which is kept at a temperature of 212° F. or over; about an hour and a half is consumed in filling to a depth of 5 feet. The material is kept in motion by a mechanical stirrer, it being of the greatest importance that the partly calcined plaster shall not remain in contact with the heated iron. The slow filling tends to keep the heat constant or nearly so during the charging, and as the boiling increases the plaster is occasionally thrown in "waves" out of the kettle. The heated material boils like thick cream, and runs almost like water. The boiling is, of course, due to the escape of the water of crystallization and the hygroscopic water that may be present. The boiling takes about three hours; a short time before completion, when the temperature reaches 270° F., there is a sudden settling down and the steam ceases to rise, marking the period of formation of the first hydrate. Soon the mass begins to boil again; after a certain time, quite accurately determined by the expert calciner, when a temperature of approximately 350° F. is reached, the charge is done, the discharge gate is opened, and the finished product runs out into a vault. The refilling of the kettle for the succeeding charge begins at once.

Retarders.—As plaster of Paris, when mixed with water, sets in from six to ten minutes, material is incorporated therewith, either during its manufacture or at the time of its preparation for use, to delay or hold back the set, in order that the cement plaster can be prepared in quantity and applied with uniform results. These compounds or admixtures are known as retarders or restrainers. In the early days of cement plaster, glue was added by the workman when he prepared the material for use; but now, to secure uniform results, the retarder is, as a rule, incorporated with the plaster in the process of manufacture. Citric acid was used for a time, but this was expensive, and the results were often uneven. As magnesian limes set more slowly than calcareous limes, it was thought that the addition of magnesian limestone would serve as a retarder, but the use of this substance is said not to be a success.

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[1] Annales de Chimie, 1874.

[2] University Geological Survey of Kansas, Vol. V, Report on Gypsum and Gypsum Cement Plasters, pages 92 to 95.

In the days of the Romans, blood was used to retard the set of plaster of Paris, and organic matter from slaughterhouse refuse (tankage, bones, hair, etc.), forms the base of many of the retarders now in use.

Any substance which, when added to the water with which calcined gypsum is mixed, or to the dry plaster, will keep the molecules apart or from too close contact will delay the crystallization and retard the setting. Such substances are dirt or organic matter not of a crystalline character. Insoluble material or carbonates of the alkaline earths will dilute the plaster so that it will not set as quickly as the unadulterated plaster. Whether a retarder weakens the cement plaster or not is a disputed question among architects and plasterers, although it is conceded that the addition of too much foreign material reduces the strength of the mass of interlacing crystals. As a general rule the prolongation of the period of crystallization or set is determined by the quantity of retarder added to or incorporated with the plaster. Calcined plaster which sets slowly, whether retarded or not, is known as cement plaster.

Accelerators.—It is a well-known fact that when a salt crystal is dropped into a supersaturated solution of a salt, as for instance sodium sulphate, the whole mass immediately crystallizes. Crystals, or even solid particles of foreign material, will hasten the crystallization. Hence, to make a quick-setting plaster, as for dental use, some other crystallizing salt, as alum or borax, is added, in small quantity, to the calcined gypsum. The result is that, after solution, the added salt has a tendency to crystallize, and thus starts the process in the dehydrated gypsum.

Processes for hardening plaster.—When calcined gypsum is steeped in a solution containing from 8 to 10 per cent of alum, and then dried and again burned with a dull red heat of uniform and constant temperature (Greenwood's process), a plaster is produced which after setting is very much harder than the ordinary plaster. Casts made of such plaster solidify gradually, but finally acquire a hardness similar to that of alabaster or marble, and present a translucent appearance resembling these substances. According to Landrin, this change in the plaster is not to be accounted for by the formation of double sulphates of lime and alkali, nor by the crystals of calcium sulphate being embedded in alumina; but rather by the calcium carbonate in the plaster stone being converted by the alum into calcium sulphate. A liquid containing from 8 to 10 per cent of sulphuric acid acts in a similar manner. Landrin analyzed alum plasters with the following results:

Landrin's analyses of alum plasters.

DESCRIPTION OF SPECIMENS (ALUM PLASTERS).	$CaSO_4$.	CONSTITUENTS			
		$CaCO_3$.	SiO_2.	H_2O.	Total
French cement	96.75	1.05	0.72	1.48	100
English cement, No. 1	98.19	0.41	....	1.40	100
English cement, No. 2	98.02	0.37	0.42	1.19	100
Stucco	98.05	0.36	0.51	1.08	100

These figures show that the alum cements are of great purity and have no trace of alumina or potash.

Keene's hard cement is produced by impregnating plaster of Paris with a solution of 1 part of borax and 1 part of cream of tartar in 18 parts of water, drying and burning at a low red heat for six hours. Borax alone serves the purpose. The plaster hardens more slowly as the solution is more concentrated.

Silicated plaster is formed by sponging the surface of plaster casts with a solution formed by first adding whey, free from fatty matter, to a potash lye solution made by adding 1 part of potash to 5 parts of water, and afterwards mixing 4 parts of this with a simple solution of potassium silicate.

Stearin melted at not too high a temperature has been employed as a bath in which plaster casts are immersed.

Landrin found that lime had great influence on plasters. By mixing lime with the plaster in different proportions, not to exceed 10 per cent, he obtained plaster which set regularly, became very hard, and took a high polish.

A large number of patents have been issued for retarding compounds and admixtures, and for prepared plasters, as well as for processes of manufacture and for hardening gypsum, and a digest of the same will be found in an appendix. There have also been issued some 280 or more patents for improvements in the arts involving the use of gypsum or plaster of Paris in the manufacture of artificial stone, wall and roofing cements, pavements, crayons, blackboards, heat insulating composition, etc.

TABLE 6.—DETAILED SUMMARY: 1902.

	United States.	Iowa.	Kansas.	Michigan.	New York.	Oklahoma.	Wyoming.	All other states.[1]
Number of mines or quarries	62	9	7	6	17	5	3	15
Number of operators	45	3	5	4	15	3	2	13
Character of ownership:								
Individual	13				7		1	5
Firm	6				2			4
Incorporated company	26	3	5	4	6	3	1	4
Salaried officials, clerks, etc.:								
Total number	249	20	19	127	22	12	6	43
Total salaries	$300,420	$15,883	$20,150	$171,245	$32,600	$8,208	$4,228	$48,106
General officers—								
Number	32	2	6	4	6	4	1	9
Salaries	$73,936	$1,625	$10,000	$15,700	$24,100	$2,962	$1,600	$17,649
Superintendents, managers, foremen, surveyors, etc.—								
Number	113	11	6	64	6	6	2	18
Salaries	$153,095	$9,550	$6,110	$108,656	$3,675	$4,700	$1,703	$19,301
Foremen below ground—								
Number	12	3	1	1	4			3
Salaries	$8,948	$2,228	$900	$825	$2,705			$2,290
Clerks—								
Number	92	4	6	58	6	2	3	13
Salaries	$64,441	$2,480	$3,140	$46,064	$2,120	$546	$925	$8,866
Wage-earners:								
Aggregate average number	1,472	293	146	359	211	66	15	379
Aggregate wages	$759,258	$170,828	$71,261	$176,607	$100,996	$34,408	$7,675	$197,483
Above ground—								
Total average number	1,085	149	119	313	141	66	15	282
Total wages	$551,593	$86,020	$58,026	$152,143	$67,408	$34,408	$7,675	$145,913
Engineers, firemen, and other mechanics—								
Average number	101	13	10	28	12	9	1	28
Wages	$63,714	$7,531	$6,254	$17,880	$6,735	$5,878	$582	$18,934
Miners or quarrymen—								
Average number	246	1	12	119	42	16	3	53
Wages	$121,546	$704	$5,973	$55,256	$20,116	$8,309	$1,380	$29,808
Boys under 16 years—								
Average number	3							3
Wages	$500							$500
All other wage-earners—								
Average number	735	135	97	166	87	41	11	198
Wages	$365,833	$77,785	$45,799	$79,007	$40,557	$20,221	$5,713	$96,671
Below ground—								
Total average number	387	144	27	46	73			97
Total wages	$207,665	$84,808	$13,235	$24,464	$33,588			$51,570
Miners—								
Average number	368	133	27	46	73			89
Wages	$198,060	$78,948	$13,235	$24,464	$33,588			$47,825
All other wage-earners—								
Average number	19	11						8
Wages	$9,605	$5,860						$3,745
Average number of wage-earners at specified daily rates of pay:								
Engineers—								
$1.25 to $1.49	1							1
$1.50 to $1.74	3		1		1			1
$1.75 to $1.99	4		1		1	1		1
$2.00 to $2.24	21	6	2	4	5	1		3
$2.25 to $2.49	7	2	3			1		1
$2.50 to $2.74	13		1	6	1	2	1	2
$3.00 to $3.24	1							1
$4.00 to $4.24	2							2
Firemen—								
$1.00 to $1.24	1		1					
$1.50 to $1.74	5			4		1		
$1.75 to $1.99	13	3		4	1			5
$2.00 to $2.24	7	2		1	1	1		2
$2.25 to $2.49	1		1					
$2.50 to $2.74	2					1		1
Machinists, blacksmiths, carpenters, and other mechanics—								
$1.25 to $1.49	1							1
$1.50 to $1.74	1							1
$1.75 to $1.99	3				1			2
$2.00 to $2.24	8			6		1		1
$2.25 to $2.49	4			3	1			
$3.00 to $3.24	1							1
$4.00 to $4.24	1							1
$4.25 and over	1							1
Miners or quarrymen—								
$1.25 to $1.49	25		12		4			9
$1.50 to $1.74	329	23	10	149	90	7	3	47
$1.75 to $1.99	158	52	6	15	18	6		61
$2.00 to $2.24	50	22	11	1	3	3		10
$2.25 to $2.49	21	16						5
$2.50 to $2.74	22	21						1
$3.00 to $3.24	9							9
Boys under 16 years—								
$0.50 to $0.74	3							3
All other wage-earners—								
$0.75 to $0.99	1							1
$1.00 to $1.24	32				1		4	27
$1.25 to $1.49	55		20		3	5		27
$1.50 to $1.74	416	7	57	163	72	29		88
$1.75 to $1.99	161	96	14	3	11			37
$2.00 to $2.24	64	27	6			7	7	17
$2.25 to $2.49	16	16						
$3.00 to $3.24	9							9

[1] Includes operators distributed as follows: California, 1; Colorado, 1; Montana, 2; Nevada, 1; Ohio (2 mines; operator reported in Michigan); Oregon, 1; South Dakota, 2; Texas, 2; Utah, 1; Virginia, 2.

TABLE 6.—DETAILED SUMMARY: 1902—Continued.

	United States.	Iowa.	Kansas.	Michigan.	New York.	Oklahoma.	Wyoming.	All other states.
Average number of wage-earners employed during each month:								
Men 16 years and over—								
January	770	127	109	142	68	24	8	292
February	1,271	251	138	350	194	49	12	277
March	1,304	225	144	350	198	49	16	322
April	1,450	218	153	400	203	49	15	412
May	1,521	231	152	399	221	69	16	433
June	1,608	332	149	401	217	67	15	427
July	1,590	318	145	402	222	67	18	418
August	1,499	323	143	403	230	67	16	317
September	1,693	387	170	402	247	67	16	404
October	1,683	393	155	353	262	92	18	410
November	1,656	374	150	353	254	102	15	408
December	1,583	337	144	353	252	90	15	392
Boys under 16 years—								
January	3							3
February	3							3
March	3							3
April	3							3
May	3							3
June	4							4
July	4							4
August	4							4
September	3							3
October	2							2
November	2							2
December	2							2
Contract work:								
Amount paid	$406							$406
Number of employees	7							7
Miscellaneous expenses:								
Total	$200,769	$6,505	$27,181	$44,715	$14,081	$11,118	$4,452	$92,717
Royalties and rents of mine and mining plant	$49,912	$1,088	$3,507		$7,501	$7,605	$817	$29,394
Rent of offices, taxes, insurance, interest, and other sundries	$150,857	$5,417	$23,674	$44,715	$6,580	$3,513	$3,635	$63,323
Cost of supplies and materials	$341,760	$47,683	$25,626	$88,634	$31,175	$24,097	$15,523	$109,022
Product:								
Gypsum, short tons	816,478	150,323	62,101	240,227	110,364	34,156	9,801	209,506
Gypsum calcined, short tons (before calcination)	674,232	147,723	59,770	158,320	75,230	34,156	9,801	189,232
Marketable product—								
Total quantity, short tons	681,633	120,779	50,147	208,563	95,318	27,325	7,841	171,660
Total value	$2,089,341	$337,734	$205,560	$459,621	$259,170	$111,215	$38,372	$677,669
Crude—								
Quantity	81,455	600		68,885	9,153			2,817
Value	$93,914	$900		$70,460	$15,184			$7,370
Land plaster—								
Quantity	60,791	2,000	2,331	13,022	25,981			17,457
Value	$106,237	$3,000	$3,497	$16,340	$43,750			$39,650
Calcined plaster—								
Quantity	539,387	118,179	47,816	126,656	60,184	27,325	7,841	151,386
Value	$1,889,190	$333,834	$202,063	$372,821	$200,236	$111,215	$38,372	$630,649
Power owned:								
Total horsepower	7,319	1,305	555	1,675	1,469	430	212	1,673
Engines—								
Steam—								
Number	68	14	8	11	13	5	3	14
Horsepower	6,385	1,305	455	1,565	1,225	430	212	1,193
Gas or gasoline—								
Number	2				2			
Horsepower	20				20			
Water wheels—								
Number	11		1	1	6			3
Horsepower	914		100	110	224			480
Electric motors—								
Number	5			1				4
Horsepower	68			25				43

APPENDIX.

DIGEST OF UNITED STATES PATENTS.[1]

GYPSUM AND PLASTER OF PARIS.

I—PROCESSES.

II—RETARDERS.

I—*Processes.*

1361—October 9, 1839. J. D. GREENWOOD and R. W. KEENE. *Cement for forming artificial stone.*

Gypsum is saturated with water in which 1 pound of alum to the gallon has been dissolved and then dried and calcined.

211066—December 17, 1878. C. T. TOMKINS. *Preparing gypsum for use in paper making and other purposes.*

Minutely crystalline sulphate of lime is formed by subjecting gypsum to continuous agitation in a tank with water and to a continuous circulation.

308111—November 18, 1884. J. H. TRICKEY. *Art or process of and composition for making artificial stone.*

It is composed of plaster of Paris, glycerin, and water, and is boiled in a solution of brimstone after becoming set and dried.

309612—December 23, 1884. R. B. EASON and J. J. MCGIRVENY. *Cement composition for molding brick, etc.*

A mixture of gypsum and ashes in about equal proportions in a dry pulverized state is boiled in water without agitation until the water is evaporated and the mass dried out.

326047—September 8, 1885. W. MANNING. *Process of treating gypsum.*

Alabaster in the form of a dry precipitated powder is formed by subjecting gypsum to grinding, calcining, and agitation in water, then floating in a floating apparatus, then forcing through a filter, and afterwards drying, crushing, and grinding.

342784—June 1, 1886. U. CUMMINGS. *Manufacture of cement.*

For the manufacture of a hydraulic or Portland cement a mixture of clay 400 pounds and gypsum 1,266 pounds is calcined.

343181—June 8, 1886. E. W. MARSH. *Process of calcining gypsum.*

Ground gypsum in a suitably constructed kettle is exposed to the heat of superheated steam.

395159—December 25, 1888. W. MANNING. *Process of treating gypsum.*

To produce an impalpable opaque anhydrous powder, gypsum is subjected to a second calcination and subsequent reduction by crushing and grinding.

519259—May 1, 1894. H. C. HIGGINSON. *Manufacture of plaster.*

The plaster is heated to about 395°, then cooled to about 365°, and then given a temperature of about 380° and discharged at such temperature.

549151—November 5, 1895. G. W. PARKER. *Process of treating gypsum rock to imitate chalcedony.*

The rock is dehydrated by the action of hot air, and the porous rock is then allowed to absorb a solution of sulphate of iron, nitric acid, and potassium sulphocyanide, after which it is immersed in a solution of aluminum sulphate, $Al_2(SO_4)_3$, for 15 hours, then exposed to the air and polished.

588287—August 17, 1897. G. W. PARKER. *Process of treating gypsum rock to imitate marble.*

The moisture is first removed from the rock by the action of hot air, then the hot rock is placed in a closed compartment charged with the fumes of ammonia, and the cool rock is then immediately immersed in a solution of aluminum sulphate until the pores are filled.

634709—May 9, 1899. F. P. VAN HOOK. *Method of producing plaster products.*

The material is calcined to a pulverulent condition and then, while intensely heated, subjected to the action of a current of cold air of such strength that the particles are taken up and carried in suspension, and rapidly cooled.

655501—August 7, 1900. L. H. MERCERON-VICAT. *Artificial cement.*

Natural marly limestone, or a prepared mixture of calcareous matter and clay, containing sulphur, is calcined and then fused under oxidizing conditions, thereby removing the sulphur while the materials are in a state of fusion.

661247—November 6, 1900. W. R. JOHNSON. *Process of revivifying old plaster of Paris.*

It is subjected to two heatings and an intermediate wetting with acidulated water, the first heating effecting a more complete removal of water than the second, while the intermediate wetting serves to rehydrate the burnt plaster.

674760—May 21, 1901. A. E. CUMMER. *Process of treating hydrous compounds.*

The raw material is heated until dehydration has commenced and has been partially completed, and then the dehydration is completed by the resident heat of the material out of contact with the air.

678412—July 16, 1901. W. LESSING. *Process of burning cement, gypsum, etc.*

The ground raw material is heated to a white heat and dropped downwardly against a column of flame, then cooled, and the resulting heat used for generating steam and for the preliminary warming of the material.

II—*Retarders.*

101253—March 29, 1870. A. H. FREAR. *Manufacture of artificial stone.*

Employs an aqueous saccharine solution of litharge in the manufacture of artificial stone.

165513—July 13, 1875. A. BOAG. *Composition for stone cements.*

Calcined gypsum is saturated with a solution of 1 pound of saltpeter to 4 gallons of water; it is then dried and ground.

225261—March 9, 1880. O. F. WOODWARD. *Composition for making molded articles of manufacture.*

Gypsum and rosin, say in the proportion of 125 pounds of gypsum and 100 pounds of rosin, are mixed together under heat.

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[1] Printed copies of patents are sold by the Commissioner of Patents at 5 cents each.

291508—January 8, 1884. H. Graf. *Plastering composition.*

Uses glue and glycerine, together with plaster of Paris, slaked lime, sawdust, and hair.

321620, 321621—July 7, 1885. E. and E. W. Marsh. *Composition of matter to be used as a plaster for building purposes.*

Uses as retarder resin lac dissolved in a solution of caustic soda.

368594—August 23, 1887. G. R. King. *Compound to restrain the setting of plaster.*

The restrainer consists of glue and ground stone.

390157—September 25, 1888. J. Coy. *Composition of matter for plastering, etc.*

. The restrainer consists of glue, Irish moss, molasses, and tartaric acid.

391889, 391890—October 30, 1888. J. H. Fitzgerald. *Plastering composition.*

Uses sugar as a restrainer.

392528—November 6, 1888. C. Straub. *Composition of building material for architectural purposes.*

Magnesia is mixed with dissolved glue or gelatinous matter, hydrocarbon compound, acid, and pulverized calcined material, the magnesia producing a smooth and glossy surface.

397296—February 5, 1889. G. R. King. *Compound to restrain the setting of plaster, etc.*

It is composed essentially of animal gelatinous or vegetable glutinous matter and hydrated lime.

409012—August 13, 1889. M. B. Church. *Ornamentation of walls.*

A fatty matter such as oil or glycerine is added as a retarder to alabastine, a mixture of calcined gypsum and glue.

422171—February 25, 1890. G. West. *Composition of matter for architectural purposes.*

A compound of glue and sal soda to be used with plastering material.

422269—February 25, 1890. G. West. *Plastering compound.*

A compound of glue, dextrin, and sal soda to be used with plastering material.

422270—February 25, 1890. G. West. *Composition of matter for architectural purposes.*

It consists essentially of glue or other well-known retarder and boracic acid.

427591—May 13, 1890. R. B. and E. H. Martin. *Wall-covering composition.*

Citric acid is used as a retarder.

433743—August 5, 1890. S. S. Ruston, W. E. Hopkins, and B. Ruston. *Process of manufacturing plastering compounds.*

A dry pulverulent restraining compound is produced by dissolving the restraining substance in water, and mixing therewith a dry, absorbent, comminuted material, by stirring under the application of heat, until it is converted to a dry, pulverulent state.

433899—August 5, 1890. H. Leichsenring. *Artificial plaster.*

It consists of glycolline, plaster of Paris, and water.

437140—September 23, 1890. J. Sickler. *Process of calcining gypsum.*

The retarding agent is incorporated with the plaster during the process of calcining, and while it is in a molten condition and prior to complete calcination.

445211—January 27, 1891. E. Watson. *Composition of matter for retarding the setting of plaster.*

Hair is boiled with an alkali, caustic soda or potash, and used in liquid form, or evaporated and reduced to a powder.

446604—February 17, 1891. E. Watson. *Composition of matter for restraining the setting of plaster compounds.*

A dry leguminous substance, such as peas, beans, lentils, etc., treated with a solution of caustic alkali, mixed with an alkaline earth or a salt of an alkaline earth, or a salt of a caustic alkali, dried and pulverized.

452346—May 12, 1891. I. C. Hart. *Plastering compound.*

Lime is dry slaked with glue water.

456297—July 21, 1891. A. Anthony. *Plastering composition.*

Uses as a retarder in a specified plastering composition a submixture of sugar, slaked lime, and bicarbonate of soda.

458742—September 1, 1891. E. Watson. *Composition of matter for restraining the setting of plaster.*

A mixture of flaxseed or oil meal cake and an alkali, as carbonate of soda or potash, is reduced to a dry powder.

458743—September 1, 1891. E. Watson. *Composition of matter for restraining the setting of plaster.*

Comminuted hoof, horn, or feathers is dissolved by boiling in a solution of caustic alkali, dried, and reduced to a powder.

462678—November 10, 1891. G. W. Abell. *Composition of matter for wall coverings.*

A mixture of white lead, litharge, sugar, linseed (oil cake) meal, lime, calcined gypsum, sand, and water, in specified proportions.

465614—December 22, 1891. G. E. Coy. *Compound to restrain the setting of plaster, and process of making the same.*

A mixture of pulverous quicklime, glue, and flour.

469394—February 23, 1892. G. W. Abell. *Composition of matter for covering walls or other surfaces.*

A mixture of dry oxide of zinc, sugar, flour of sulphur, wood pulp, linseed (oil cake) meal, ground gypsum, lime, sand, and water in specified proportions.

472342—April 5, 1892. E. Watson. *Composition for retarding the solidification of calcined gypsum.*

It consists essentially of calcined gypsum and "tank water;" to retard the setting from half an hour to three hours or more, from 2 to 10 gallons to a ton of calcined gypsum, or of the semisolid substance, stick, from 2 to 10 pounds to the ton, or from 5 to 15 pounds of dry material, formed by mixing any earthy substance, siliceous or aluminous, with tank water and drying and pulverizing.

472511—April 5, 1892. W. Robinson. *Wall plaster.*

A mixture of sand, plaster of Paris, glue, lime, clay, alum, and starch.

478951—July 12, 1892. C. Cassteel. *Plaster.*

A composition consisting of water, lime, gypsum, and coke, or brick dust, with a small proportion of a mixture of sugar, alum, and lime as a retarder.

479060—July 19, 1892. E. W. Dickie. *Composition of matter for plastering.*

A mixture of sand, plaster of Paris, shell marl, and cut rope, or hair, with glue, alum, and sulphate of zinc as a restrainer, combined in a specified manner and proportions.

485177—November 1, 1892. C. L. Denison. *Wall plaster.*

A composition consisting of lime, cottonseed meal, plaster of Paris, borax, and cream of tartar.

493613—March 14, 1893. E. A. Bronson. *Compound for retarding the setting of cement.*

It is composed of air-slaked lime, glue, flaxseed, or oil cake, and china clay, in specified proportions.

502686, 502687—July 25, 1893. T. J. Heller. *Plaster composition.*

A compound for admixture with a plaster composition consisting of silicate and carbonate of soda, alum, sugar, gum, salt cake, and ground inert material.

503592—August 22, 1893. J. Flynn. *Composition for architectural purposes.*

The retarder, combined with other ingredients, consists of a solution of carbonate of potash and glue absorbed in quicklime.

504933—September 12, 1893. E. A. Moore. *Composition for architectural purposes.*

A mixture of dry pulverous glue, sulphuric acid, kerosene oil, and quicklime, as a retarder, is combined with sand, raw gypsum, and lime.

507942—October 31, 1893. B. D. Stafford. *Composition for plaster and coating walls.*

It consists of powdered borax, powdered alum, wheat flour, powdered sugar, and dry slaked lime in specified proportions.

511735—December 26, 1893. J. K. Jones. *Wall plaster.*

The retarder is composed of sugar, 100 parts; flour, 25 parts; and air-slaked lime, 250 parts.

511740—December 26, 1893. J. R. McIlvried. *Process of manufacturing retarders for plaster.*

A paste is formed of air-slaked lime, water, flour, liquid glue, and wood ashes, dried and thoroughly mixed.

511879—January 2, 1894. W. M. Dawson. *Plastic compound and process of making same.*

The restrainer consists of a mixture of lime with the liquor obtained by the decomposition of organic matter in water.

523658—July 31, 1894. W. M. Dawson. *Plastering retarder and method of making same.*

The restrainer consists of a mixture of lime, sodium nitrate, and the liquor obtained by the decomposition of organic matter in water.

528995—November 13, 1894. A. W. Smith. *Plastering compound.*

The restrainer consists of lime, glue, wheat flour, and tartaric acid in certain proportions.

533420—February 5, 1895. W. H. Aikman. *Building plaster.*

As an ingredient of building plaster, a compound of alum, wheat flour, sugar, lime, oil cake meal, and zinc sulphate in specified proportions.

554142—February 4, 1896. W. M. Reese. *Plaster.*

A mixture of pulverized gypsum and dry tankage in the proportions of 10 pounds of tankage to a ton of gypsum, is calcined and the heat continued to a temperature of 380° to 420° F.

558435—April 14, 1896. J. E. Summers. *Plastering compound.*

A mixture of furnace slag, slaked lime, plaster of Paris, hydraulic cement, the flour of grain, and vegetable fiber in specified proportions.

619911—February 21, 1899. H. E. Sturcke. *Manufacture of plaster and restrainers.*

The restrainer consists essentially of the pulverized residue of an evaporated solution of bone in alkali.

PHOSPHATE ROCK

PHOSPHATE ROCK.

By Joseph Struthers, Ph. D.

Prior to the report of 1880 no figures relating to the production of phosphate rock appeared in census reports. In that year 21 establishments were reported in South Carolina, with a product of 211,377 tons, valued at $1,123,823. At the Eleventh Census the production for 1889 was shown, and the totals, compared with those for 1902, appear in Table 1.

Table 1.—*Comparative summary: 1902 and 1889.*

	1902	1889
Number of mines or quarries	115	(1)
Number of operators	87	(1)
Salaried officials, clerks, etc.:		
Number	391	(2)
Salaries	$356,204	(2)
Wage-earners:		
Average number	5,971	[3]5,011
Wages	$1,930,093	[4]$1,209,151
Contract work	$157,402	$115,930
Miscellaneous expenses	$430,475	$343,271
Cost of supplies and materials	$799,414	$317,159
Product:[5]		
Quantity, long tons	1,548,720	550,245
Value	$4,922,943	$2,937,776

[1] Not reported.
[2] Not reported separately.
[3] Includes foremen.
[4] Includes salaries of office force.
[5] The United States Geological Survey reports 1,490,314 short tons, valued at $4,693,444, which is the product marketed. The Census figures represent the product mined.

The most notable fact in the industry is the transfer of dominance from South Carolina to Florida. During the period between 1889 and 1902 the production in Florida increased nearly one hundredfold in quantity and over sixtyfold in value; at the same time that of South Carolina decreased 39.5 per cent in quantity and 67.1 per cent in value. The increase in Florida was due chiefly to the exportation of phosphate rock which is easily mined near tide water. Tennessee did not produce any rock in 1889, but in 1902 the production of the state was 432,603 long tons, valued at $1,308,872. This rock, however, was of low grade, averaging in value only $3.03 per ton. North Carolina did not report any product in 1902 and in 1889 its production reached a total valuation of only $5,000. By the growth of the industry in Florida and in Tennessee the production for the United States as a whole increased 181.5 per cent in quantity and 67.6 per cent in value.

Among the most significant items of Table 1 are those relating to wage-earners and their earnings. By this table it appears that the number of salaried officials, clerks, etc., and wage-earners increased 1,351, or 27 per cent, while the amount paid in salaries and wages increased 89 per cent. The number of boys employed was not large in either year, and although the industry increased in all other respects, the number of boys decreased from 91 to 37, or 59.3 per cent. In South Carolina. where 90 boys were employed in 1889, none were reported in 1902. The figures in Florida in 1889, however, do not offer a wholly satisfactory basis upon which to make comparisons. Mining operations had been recently begun, and the industry was in a condition of speculative excitement.

There were 19 mines in Florida, South Carolina, and Tennessee reported idle during 1902, and 2—1 each in Florida and North Carolina—at which development work was reported. The statistics for the development work at these 2 mines are shown in the following statement:

Development work: 1902.

Number of mines	2
Number of operators	2
Salaried officials, clerks, etc.:	
Number	4
Salaries	$4,315
Wage-earners:	
Average number	5
Wages	$1,322
Miscellaneous expenses	$666
Cost of supplies and materials	$728

Capital stock of incorporated companies.—The details of the capitalization of the 56 incorporated companies are shown by states in Table 2:

TABLE 2.—*Capitalization of incorporated companies: 1902.*

	United States.	Florida.	South Carolina.	Tennessee.	All other states.[1]
Number of incorporated companies	56	24	9	21	2
Number reporting capitalization	53	21	9	21	2
Capital stock and bonds issued	$13,775,935	$5,982,800	$1,634,500	$5,957,200	$201,435
Capital stock:					
Total authorized—					
Number of shares	204,955	98,755	21,150	63,550	21,500
Par value	$13,269,500	$5,003,000	$1,995,000	$6,070,000	$201,500
Total issued—					
Number of shares	194,796	97,734	16,465	59,162	21,435
Par value	$12,321,135	$4,962,000	$1,526,500	$5,631,200	$201,435
Dividends paid	$316,205	$104,380	....	$211,825	....
Common—					
Authorized—					
Number of shares	184,955	96,655	21,000	45,800	21,500
Par value	$11,292,000	$4,793,000	$1,980,000	$4,317,500	$201,500
Issued—					
Number of shares	174,796	95,634	16,315	41,412	21,435
Par value	$10,343,635	$4,752,000	$1,511,500	$3,878,700	$201,435
Dividends paid	$179,115	$72,490	....	$106,625	....
Preferred—					
Authorized—					
Number of shares	20,000	2,100	150	17,750	....
Par value	$1,977,500	$210,000	$15,000	$1,752,500	....
Issued—					
Number of shares	20,000	2,100	150	17,750	....
Par value	$1,977,500	$210,000	$15,000	$1,752,500	....
Dividends paid	$137,090	$31,890	....	$105,200	....
Bonds:					
Authorized—					
Number	4,530	3,986	108	436	....
Par value	$1,735,800	$1,276,800	$108,000	$351,000	....
Issued—					
Number	3,518	3,024	108	386	....
Par value	$1,454,800	$1,020,800	$108,000	$326,000	....
Interest paid	$61,750	$55,510	$3,240	$3,000	....

[1] Includes companies distributed as follows: Arkansas, 1; Ohio, 1.

The total amount of common and preferred stock issued amounted to $12,321,135. On this amount $316,205 was paid in dividends, or 2.6 per cent on the total par value. On the bonded indebtedness $61,750 was paid as interest. This was 4.3 per cent of the par value of the amount issued. In Tennessee the dividends on common stock amounted to 2.7 per cent, and those on preferred stock to 6 per cent on the respective par values of the stock issued. In Florida, with a capitalization quite similar in amount, dividends were paid on common stock at the rate of 1.5 per cent, and on preferred stock at the rate of 15.2 per cent.

Employees and wages.—The average number of wage-earners reported for each month in Table 6 shows that the demand for labor was relatively steady throughout the year. In the South the climate is favorable to the continuous working of deposits. Between September, for which month 6,442 wage-earners, the maximum number, were reported, and February, when 5,366 wage-earners, the minimum, were at work, there is a variation of only 1,076. The average per month for the year was 5,971 wage-earners. Child labor constituted six-tenths of 1 per cent of the total, and was confined mostly to the small colored boys who drove carts. Florida employed 48 per cent of the total number of wage-earners; South Carolina, 25.1 per cent; Tennessee, 26.7 per cent; and all other states, two-tenths of 1 per cent.

A segregation of the occupations in this industry by specified daily rates of pay is shown in Table 3.

TABLE 3.—*Average number of wage-earners by specified daily rates of pay: 1902.*

RATE PER DAY (DOLLARS).	All occupations.	Engineers.	Firemen.	Machinists, blacksmiths carpenters, and other mechanics.	Miners or quarrymen	Timbermen and track layers.	Boys under 16 years.	All other wage-earners.
Total	5,971	173	169	171	4,382	111	37	928
Less than 0.50	52	......	......	......	......	......	7	45
0.50 to 0.74	89	......	......	1	6	......	27	55
0.75 to 0.99	1,288	......	14	20	1,010	10	2	232
1.00 to 1.24	3,656	5	76	8	2,990	100	1	476
1.25 to 1.49	378	5	37	28	226	......	......	82
1.50 to 1.74	250	52	27	25	126	......	......	20
1.75 to 1.99	25	3	3	4	1	1	......	13
2.00 to 2.24	101	47	7	35	7	......	......	5
2.25 to 2.49	33	24	1	7	1	......	......	......
2.50 to 2.74	55	20	4	29	2	......	......	......
2.75 to 2.99	3	1	......	......	2	......	......	......
3.00 to 3.24	21	11	......	6	4	......	......	......
3.50 to 3.74	4	2	......	1	1	......	......	......
3.75 to 3.99	3	......	......	1	2	......	......	......
4.00 to 4.24	5	2	......	1	2	......	......	......
4.25 and over	8	1	......	5	2	......	......	......

Of the wage-earners, 1,429, or 23.9 per cent of the whole, received less than $1 per diem, and 5,085, or 85.2 per cent, less than $1.25. Only 233, or 3.9 per cent, received $2 or more per diem. Of the wage-earners in Florida 5.9 per cent received $1.75 or more per diem, while in South Carolina the corresponding percentage was 3.9. In Tennessee only 1.9 per cent received $1.75 or more.

Mechanical power.—The primary power reported for this industry aggregated 14,229 horsepower, all owned by the operators reporting, distributed as follows: 282 steam engines with a horsepower of 13,974, 1 water wheel of 170 horsepower, and 2 air compressors of 85 horsepower. There were also 9 electric motors with 500 horsepower.

Production.—The quantity and value of the production of phosphate rock, beginning with 1889, are shown in Table 4.

TABLE 4.—*Production of phosphate rock: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (long tons).	Value
1889	550,245	$2,937,776
1890	510,499	3,213,795
1891	587,988	3,651,150
1892	681,571	3,296,227
1893	941,368	4,136,070
1894	996,949	3,479,547
1895	1,038,551	3,606,094
1896	930,779	2,803,372
1897	1,039,345	2,673,202
1898	1,308,885	3,453,460
1899	1,515,702	5,084,076
1900	1,491,216	5,359,248
1901	1,483,723	5,316,403
1902	1,490,314	4,693,444

During this period the quantity of production has increased 170.8 per cent. The greatest amount produced in any one year was 1,515,702 long tons in 1899. In 1889 the average value per ton was $5.34, while in 1902 it was $3.15. The production of phosphate rock in the world, from 1896 to 1901, is given in Table 5.

TABLE 5.—WORLD'S PRODUCTION OF PHOSPHATE ROCK: 1896 TO 1901.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Metric tons.]

COUNTRY.	1896		1897		1898		1899		1900		1901	
	Quantity.	Value.	Quantity.	Value.	Quantity	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Algeria	165,738	$500,906	228,141	$912,564	269,500	$1,078,000	324,983	$1,299,932	319,422	$1,277,688	265,000	$1,060,000
Belgium	[1]297,470	687,320	[1]350,056	435,762	[1]166,920	303,230	[1]190,090	342,180	[1]215,670	367,164	222,520	361,398
Canada	517	3,420	824	3,984	665	3,665	2,722	18,000	1,284	7,105	937	6,290
France	582,667	3,502,027	535,390	2,852,887	568,508	3,115,958	645,868	3,331,145	587,019	2,827,291	585,676	2,614,543
Norway	1,106	17,280	872	12,960	3,593	53,352	1,500	22,140	300	4,445	(2)	....
Redonda (British West Indies)	....	....	812	5,525	750	4,725	1,567	9,270	2,280	13,720	Nil.	....
Russia	3,776	11,065	5,917	22,132	1,870	4,784	16,863	58,640	25,663	(3)	(2)	....
Spain	770	3,080	2,084	16,672	4,500	46,003	3,510	35,100	4,170	18,590	4,230	16,880
United Kingdom	3,048	26,250	2,032	17,500	1,576	13,565	1,409	12,645	630	5,425	71	690
United States	945,282	2,803,372	1,056,322	2,673,202	1,330,264	3,453 460	1,540,506	5,084,076	1,515,179	5,359,248	1,507,681	5,316,403

[1] Cubic meters. [2] Statistics not yet available. [3] Value not reported.

The detailed statistics of the industry for 1902 are given in Table 6.

DESCRIPTIVE.

The name phosphate is applied to the salts of phosphoric acid, chiefly "orthophosphoric" acid, which is a tribasic acid (H_3PO_4) and from which a great variety of salts are obtained. Each of the three hydrogen atoms in the acid can be replaced by a monad element, forming, consequently, three varieties of salts, namely, those in which one hydrogen atom is replaced, those in which two hydrogen atoms are replaced, and those in which all of the hydrogen atoms are replaced. Salts in which all of the hydrogen atoms have been replaced are called ortho or neutral phosphates, while those still containing one or two atoms of hydrogen are called acid phosphates. Calcium phosphate, or, more strictly speaking, tricalcium orthophosphate, is the most important of the mineral phosphates and this class forms the large mineral deposits utilized for the manufacture of fertilizers.

Historical.—According to historical records, the Romans utilized the excrement of birds for fertilizing the soil, and in the twelfth century the Arabs and Peruvians used the guanos of their respective countries for a like purpose.

The waste clippings of bone and ivory from the button and knife factories of Sheffield, England, greensand from the counties of Kent and Essex, England, marls from the state of New Jersey, and boneblack (spent animal charcoal) and crushed bones were used as fertilizers at different times during the eighteenth and nineteenth centuries, but while the beneficial results from their use were recognized and appreciated, the real cause of the stimulating effect seems not to have been definitely recognized until Dr. Justus von Liebig, of Geissen, Germany, evolved the idea that sulphuric acid should be added to bone fertilizers in order to render soluble the phosphate they contained. It was not until the year 1843 that the Duke of Richmond, after an exhaustive series of experiments upon the soil with both fresh and degelatinized bones, came to the conclusion that their value for fertilizing purposes was due to the large quantity of phosphoric acid contained in them. To prove this effect a number of vegetables were planted in burnt sand rich in every element of fertility except phosphoric acid; no development of the plant took place until calcium phosphate had been added to the sand, but after this addition the growth became flourishing.[1]

The calcium phosphate in bones had hitherto been considered as useless owing to its insolubility, and the fertilizing element was considered to be the gelatinous matter. Shortly after 1840 Mr. J. B. Lawes put Doctor von Liebig's ideas into practice, and began to manufacture artificial fertilizers at Deptford (London), England, by mixing sulphuric acid with crushed bones. In the year 1845 Professor Henslow recommended that the Cambridge coprolites, rich in calcium phosphate, should be used as a substitute for bones in making fertilizers, and, acting on this suggestion, the numerous bone crushing works were quickly converted into chemical fertilizer and superphosphate factories. The coprolites of Cambridge were supplemented by the phosphate deposits in Suffolk and Bedfordshire, but it was not until twenty-five years later that the phosphate mining industry began to assume a commercial importance. This slow growth is attributed to the immense supply of guano obtained from Peru, the best beds of which did not become exhausted until between 1870 and 1875; the failure of this source of supply immediately led to the substitution of other material for the manufacture of fertilizers.

Occurrence.—In France the phosphate deposits at

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[1] Phosphates of America, by Francis Wyatt, Ph. D., page 19.

Grand Pré, in the Ardennes, began to be exploited in 1856, and small quantities of the rock in a ground state were utilized by direct addition to the soil. In 1865 other deposits were discovered on the plateau of Quercy, in the department of Lot, and in 1870 the deposits of Lot-et-Garonne, Tarn-et-Garonne, and Aveyron (known as the Bordeaux phosphates) were mined and the product sold to fertilizer manufacturers. In Spain the mining of phosphate rock began at Logrosan, province of Estremadura, about the year 1855, followed, in 1860, by the exploitation of the deposits near Caceres, the latter district yielding a considerable quantity annually until 1875. In Norway phosphate deposits were mined at Kragerö, in 1854, and at Oedegarten, in 1874. In Germany the Nassau phosphate deposits were discovered in 1864 and the mining of the rock commenced at once. In recent years the competition in the world's markets of higher grade and purer phosphates from other countries has caused the cessation of the exports of rock from the Lahn mines, the material of which contains a large percentage of iron and aluminum oxides. In a few of the islands of the West Indies, notably Navassa and Sombrero, prior to 1865 phosphate deposits had been opened and the product shipped to the United States and the United Kingdom.

In the United States deposits were first worked in South Carolina in 1867. From 1867 to 1877 there was a great advance in the world's production of phosphate rock. In 1873 Belgium began contributing to the world's supply from the deposits near Mons, and France increased its production very largely. In 1880 the islands of Curaçao and Oruba, in the Dutch West Indies, supplemented the output of high-grade phosphates and shipped an average of 10,000 tons for the year.

In the decade 1880 to 1890 the sources of the supply of phosphate rock altered very considerably. At the end of this period Spain, which in 1882 and 1883 shipped 100,000 tons to the United Kingdom, practically ceased to export. In France the old sources of supply had been replaced to a large extent by the newer fields in the Somme and other departments in the north. Belgium had assumed an important place, producing about 150,000 tons of phosphate from the mines at Mons alone. In the United States the South Carolina deposits had been developed to a very large extent and Florida had begun to contribute appreciably to the supply.

Characteristics and use.—The various deposits of phosphatic material have not yet been classified geologically owing to the difficulty in determining the position of several of the deposits, augmented by the large number of forms which the phosphate assumes and the complex blending of certain varieties. The common technical classification makes the broad distinction between mineral phosphates, whose origin can not be traced to animal life, and rock phosphates, more or less mineralized, but directly traceable to an organic origin. On this basis the only mineral phosphates are those containing crystalline apatite, which occur in Canada, Norway, and a few localities in Spain. The deposits at Nassau in Germany, Lot-et-Garonne, Tarn-et-Garonne, and Aveyron in France, and Logrosan and Caceres in Spain are usually included in the mineral phosphates under the arbitrary and indefinite term "phosphates." The term rock phosphates includes the remaining varieties of phosphatic limestone, coprolites, nodular phosphates, concretionary phosphates, arenaceous phosphates, sheet-rock phosphates, and bone beds.

The value of phosphate rock in the United States lies solely in its use as a fertilizer to enrich land impoverished by continual removal of crops that have grown thereon, or land which did not originally possess the components necessary for the normal growth and development of plant life.

It has been only within comparatively recent years that the relation between plants and soils has been scientifically studied. In general the manner of life in plants resembles that of animals or man, in that they require certain foods in stated proportions which are digested or assimilated, they must breathe a certain atmosphere, and they are subject to the influence of heat and cold, light and darkness. The tissues of plants, like those of animals, are composed of carbon, hydrogen, oxygen, nitrogen, and certain mineral acids or bases, notably phosphoric and sulphuric acids, lime, magnesia, iron, and potash; and the growth of a plant bears a close relation to that of an animal for the reason that it constantly absorbs elements from the soil and air to build up its structure. The relation of plant life to animal life is reciprocal. Animals breathe in the oxygen of the air and convert a small part of it into carbon dioxide, which is exhaled and returned to the air, while plants, under the action of chlorophyl and sunlight, absorb carbon dioxide from the air and decompose it into carbon and oxygen, utilizing the former to build up the cellular structure and returning the oxygen to the air. The chief elements assimilated by plants, and consequently removed from the soil when the plants are cut down and taken away, are nitrogen, phosphoric acid, and potash. These compounds play a very important part in the functions of vegetation and are the most liable to be exhausted from the soil. The estimated mean annual quantity and value of a few of the important vegetable products in the United States have been compiled as follows:[1]

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[1] Phosphates of America, page 14.

Estimated mean annual quantity and value of certain vegetable products in the United States.

	Average percentage of ash or mineral.	Quantity (bushels).	Value.
Wheat	2.06	450,000,000	$440,000,000
Maize	1.55	1,900,000,000	627,000,000
Oats	3.18	600,000,000	168,000,000
Potatoes	3.77	200,000,000	100,000,000
Hay	7.24	[1]45,000,000	360,000,000
Cotton	3.10	[2]6,500,000	250,000,000

[1] Tons. [2] Bales (480 pounds).

According to Wyatt, the total weight of the ash contained in the entire annual cereal production of the United States (wheat, maize, oats, barley, rye, and buckwheat), about the year 1890, exceeded 17,500,000,000 pounds, containing 2,714,585,473 pounds of phosphoric acid.[1] Of course, a large part of the phosphate content of the plants was returned to the soil in one form or another, but the annual loss to the soil was nearly 1,500,000 pounds of phosphoric acid.

As the area of cereal production at that time was 140,378,857 acres, these figures show that the quantity of phosphoric acid removed annually by the cereal crop is approximately 19 pounds per acre. Similarly, the quantity removed by the hay crop is calculated to be 12.5 pounds per acre. Further, it has been shown that every cow kept on pasture land carries off during a summer not less than 50 pounds of calcium phosphate in the shape of veal, butter, and cheese.[2]

These few instances show in a striking manner the enormous loss of phosphoric acid occurring in agricultural districts, and the necessity of returning to the soil those salts which have been removed therefrom.

REVIEW OF THE INDUSTRY IN THE UNITED STATES.

The phosphate deposits of the United States are described by states as follows:

Florida.—Phosphate rock occurs over a large area, extending from Lake Okeechobee on the south to the extreme northern part of the state—a distance of 240 miles, and averaging 30 miles in width. The deposits of commercial value, however, are comparatively few in number and are widely scattered throughout the region. The three chief classes of the phosphate rock product in the order of importance are hard rock, land pebble, and river pebble.

Hard rock is mined in an area of 90 by 10 miles, extending from Albion on the north to Bay City on the south. The material is obtained from pockets which vary in yield from a few tons to many thousands, and run so irregularly that it is frequently necessary to change the location of the mining plants. In former times the mining operations were limited solely to the bowlders of phosphate rock, which varied in weight from a few pounds to many tons. The mining consisted in removing the rock from the pits, drying it in the kilns, and shipping it without any additional preparation. Little capital was called for, and many hard-rock companies were formed to mine the rock, but they finally withdrew from business on account of the scarcity of deposits easy of extraction. Attention was then directed to mining the gravel phosphate, which represents the smaller or broken pieces of the bowlders that occur intermixed with clay, flint, etc., the sterile material being removed by washing in the ordinary log washer. Later, as the mining and milling processes became more complicated and costly, large central plants were erected for cheaper treatment cost, but the economies sought, however, were not realized, on account of the small size of the individual deposits and the consequent expense of transporting the crude material containing less than 15 per cent tricalcic phosphate from the mines to the mill.

At the present time the cheapest method of treatment is to have one or more removable washing plants, each of a capacity of from 40 to 50 tons of clean rock in twelve hours. These plants are so constructed that they can easily be taken down and removed to new localities. It is also the present practice to crush, wash, and screen the entire product of the mine.

The most recent practice in mining hard rock is the installation of dredges of the dipper type to mine deposits that have been worked down to the water level, particularly in those cases where it has been found impracticable to handle the water with pumps. The use of the dipper dredge is economical, and with deposits that can be handled by this method very excellent results have been obtained, so much so that deposits unworkable at a profit by the older methods of mining are now treated with commercial success, the clay, sand, and fine material being removed in log washers plentifully supplied with water. The washed rock is carefully hand picked on a picker belt, dried in kilns, which consume from 5 to 7 cords of wood per 100 tons of rock, and is then ready for shipment to market.

The average cost of production, f. o. b. at the mines during 1900 was from $3.50 to $4 per ton. According to C. G. Memminger those deposits most favorable for cheap transportation and mining are almost exhausted, and the present efficient methods of mining and handling leave but little room for diminishing the cost, consequently with the gradual exhaustion of the best deposits the cost of production must increase. It is quite probable that the cost of production of from \$3.50 to \$4. f. o. b. at the mines, is as low as it ever will be. The cost to the consumer, however, is regulated largely by the cost of transportation from mines to port of shipment.

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[1] Phosphates of America, page 15.

[2] United States Geological Survey, Bulletin 46, "Nature and Origin of Deposits of Phosphate of Lime," by R. A. F. Penrose, Jr.

Hard rock is sold on a guarantee of a minimum of 77 per cent tricalcic phosphate (bone phosphate of lime) and a maximum of 3 per cent iron and aluminum oxides. Practically the entire output is exported, chiefly to Germany. The ports for shipment of hard rock are Fernandina, Port Inglis, and Tampa, Fla., and Brunswick and Savannah, Georgia.

The land pebble phosphate rock occurs in Polk, De Soto, and Hillsboro counties, Florida, occupying an area of about 2,000 square miles, beginning a few miles north of Bartow and extending over the upper portion of the drainage basin of the Peace and Alafia rivers. During the past few years the entire product has been obtained from Polk county. The area of the occurrence of land pebble is restricted and the deposits widely scattered, rendering this branch of the industry of comparatively less importance than the others, yet several hundred thousand tons of phosphate may be obtained from a single deposit. The pebbles are roughly rounded, of a gray or brownish color, and vary in size up to two inches in diameter. In preparing the material for the market two classes of product are made, the size of the coarser being from one-sixteenth to 1 inch in diameter. The deposits are usually along the stream courses, in low swamps, or in bay heads. The thickness of the deposits varies from a few inches to 18 feet, averaging 10 feet for the district. The pebble, which usually represents less than 25 per cent of the mass, occurs in an argillaceous matrix, sometimes very sticky and tenacious, and sometimes sandy and readily disintegrated; the overburden consists of sandy soil, clay, and a so-called conglomerate rock of varying character in different parts of the deposit. The bed rock varies from a hard yellow marl to a soft, clay-like material. The highest grade of land pebble contains from 68 to 73 per cent of tricalcic phosphate and from 3 to 4 per cent of iron and aluminum oxides; the low-grade material has from 60 to 65 per cent of tricalcic phosphate and from 4 to 5 per cent of iron and aluminum oxides. At the present time land pebble is sold on a guarantee of a minimum of 68 per cent of tricalcic phosphate and a maximum of 4 per cent of iron and aluminum oxides; conditions which, in order to operate at a profit, call for an average yield of 20 per cent of pebble to the mass, an average minimum thickness of 8 feet of the deposit (yielding 3,733 tons to the acre), and an overburden not exceeding the thickness of the deposit.

Within recent years a hydraulic method of treating land pebble has been devised, which is undoubtedly the only practical method of handling this class of material. The important feature of the process is that the water which is used to break down the rock also partially disintegrates the matrix and renders the succeeding washing for the separation of the pebble a very simple operation. According to C. G. Memminger the equipment of a hydraulic plant consists of a steam shovel for removing the overburden, one or more dredges fitted with boilers of from 400 to 500 horsepower, a 10-inch centrifugal pump, hydraulic-pressure pumps, screens and washers, and barges to carry the pebble to the mill. The mill should contain a sufficient number of washers, rotary driers, elevators, boilers, and dry-storage bins of from 4,000 to 15,000 tons capacity—an equipment which calls for a heavy investment. A plant with one dredge and two driers should produce 50,000 tons of pebble per year. The method of mining is briefly outlined as follows: The overburden having been removed by the steam shovel, the dredge is launched in a suitable excavation and the suction pipe from the centrifugal pump on the dredge is laid some 150 feet in advance, where a small sump hole is opened for suction. Streams of water from two hydraulic giants, working under a pressure of from 100 to 110 pounds per square inch, are directed into the hole, which is increased to a considerable size in a short time. The suction gradually becomes lowered until the sump is formed in the bed rock. As soon as possible the giants are placed in the pit, and as the banks are cut down the material passes with the water to the sump and is pumped to the dredge, where it is screened, the pebble being thoroughly washed and separated and the débris discharged at the side of the dredge. As the pit becomes enlarged it is a good practice to use a second centrifugal pump in connection with the pump on the dredge. In this way a pit of several acres in extent can be mined. The pump and pipes are removed from the pit as soon as economy in pit size is reached. The pit is filled with water and the bank between the dredge and the pit is broken. The dredge is then moved on and operations begin afresh. The pits form a channel for the transportation of the pebble in barges. On reaching the mill the pebble is elevated, thoroughly washed, dried, and stored for shipment.

The most modern plant in this district has been equipped with electric motive power, the intention being to eliminate the dredge by using a series of electrically-driven centrifugal pumps which will force the entire material mined to the mill, a central pumping station giving the hydraulic pressure required. Under certain conditions this system promises excellent results.

An innovation at the works of one of the phosphate companies is the installation of a central plant to generate electric and hydraulic power for the mining operations. The results have proven eminently successful and under proper conditions the method promises to supersede the older and less economical ones.

The highest grade deposits with light overburden and greatest yield per acre are fast being exhausted, and fuel, which is a large item of cost, is rapidly being exhausted in the vicinity of the mines. The question of fuel supply is one of great importance in connection with the future of the industry. Large tracts of woodland have been bought up by the various companies, but wood will undoubtedly be supplemented by coal when the mines control the transportation to the point of shipment. Fuel oil also will become a possible substitute for wood under the new conditions of transportation.

The present cost of production, f. o. b. at the mines, is from $1.50 to $2 per ton, a figure that will doubtless increase very materially in the near future. The product is shipped from Port Tampa. At the present rate of production the deposits containing 68 per cent and upward of tricalcic phosphate, and low in iron and aluminum oxides, will be exhausted within a few years. Those containing from 64 to 67 per cent tricalcic phosphate and from 4 to 6 per cent iron and aluminum oxides are in very large reserves. There has been a marked tendency toward more careful methods in the preparation of the rock for the market, which is attained usually by installing one or more log washers in addition to the ordinary double log washer plant; and by crushing the rock after it has been dried, and subsequently screening it, this procedure has been productive of good results with certain classes of rock.

As the higher grade deposits become exhausted the methods of treatment must be improved in order to handle the lower grade rock at a lessened cost. As a proof of the growing scarcity of the best class of rock, deposits having an overburden of from 25 to 30 feet are now being opened up and developed. Deposits of this character a short time ago were declared unsuited for profitable working.

The excessively high transportation and terminal charges prevailing in recent years have forced miners to seek relief. One company has constructed a private railroad from the central plant at Rockwell to Port Inglis, 18 miles distant, at the mouth of the Withlacoochee river. The port is an open roadstead, and the vessels have to be loaded by lighters.

As in the case of the hard-rock miners, there have been several unsuccessful efforts to consolidate the large miners of land pebble into a community of interests, which would eliminate useless competition and enable the producers to maintain prices at a level which would admit of mining at a fair profit.

The bulk of the river pebble has been obtained from Peace river, which rises near Bartow and flows 200 miles in a southerly direction into Charlotte harbor. The Alafia river, a small stream flowing into Tampa bay, has also contributed a small quantity of river pebble, and the Caloosahatchee, Miakka, and Manatee rivers have produced a pebble of low grade.

The method of mining the river pebble consists in using dredging boats equipped with 8-inch or 10-inch centrifugal pumps, to which are attached suction pipes suspended from cranes. The pebble, being loosely mixed with sand, is readily raised by the pumps and passed into a rotary screen, which separates the sand and delivers the washed pebble onto a lighter moored alongside the dredge. When a sufficient quantity of pebble has accumulated on the lighter, it is carried to the drying plant, dried in rotary calciners, and stored in bins, from which it is finally discharged by gravity directly into cars for shipment. As the supply of pebble in the river beds became exhausted, attention was given to the deposits lying under the swamps which were formed by the river at an earlier period. Generally these deposits are covered with an overburden of sand of from 5 to 15 feet in thickness, supporting a thick growth of heavy timber. In order to obtain the river pebble from the swamp deposits the timber was removed and the overburden washed into the stream and removed by pumps; later the pebble was obtained in like manner and treated similar to the pebble in the river beds.

The total production of phosphate rock of all classes in Florida, as reported by the United States Geological Survey, based on marketed output from 1888, the year of the inception of the industry, to and including 1902, aggregates 6,606,468 long tons, valued at $24,667,099.

South Carolina.—Although the phosphate deposits in South Carolina had been known for many years, they were not recognized as such prior to the Civil War. A mining company was formed in 1867 to test the practicability of working the phosphate rock on a commercial scale. The phosphate "belt" is composed of Quaternary sands and clays overlying beds of Eocene marls upon whose surface, and intermixed with it, are found the phosphate deposits. The presumed total area of the phosphate formation is 70 by 30 miles, extending from the mouth of the Broad river, near Port Royal on the southeast, to the headwaters of the Wando river in the northeast, its major axis being parallel to the coast line and its greatest width near Charleston. The stratum of phosphate rock sometimes outcrops at the surface, but it is generally found at a depth of from 3 to 20 feet and varies in thickness from a few inches up to 3 feet. The chief points for consideration in order to ascertain the value of the phosphate beds are thickness of deposit, depth below the surface, and richness in phosphoric acid.

In South Carolina the general method of ascertaining the value of a phosphate rock deposit is by means of boring and pit sinking. At first a careful topographical survey of the property is made, followed by the systematic sinking of a series of bore holes by means of a long steel borer or rod specially designed for the purpose. The boring rod is forced downward through the upper strata until it strikes the solid bed of phosphate rock, which makes itself evident by resisting the further passage of the rod. The rod is then removed, and the distance it has traversed is measured with a foot rule, thus showing the thickness of the overlying strata. The rod is replaced in the bore hole, forced through the resisting stratum, and again withdrawn and measured, the difference between the first and second measurements being taken as representing the thickness of the phosphate bed. The bore holes are generally 100 feet apart, extending over the entire area of the land under examination. A series of exploring pits 10 feet long and 5 feet wide are dug at 500-foot intervals in order to verify and confirm the results obtained by the bore holes. The phosphate rock is carefully removed, the depth from the surface and the thickness of the bed is measured, and average samples of the rock and nodules are obtained for analysis. Throughout the area of the South Carolina field the strata overlying the phosphate rock are remarkably uniform. Heretofore, mining operations have been limited to material occurring not more than 15 feet from the surface, but there are larger areas containing phosphate rock at a greater depth than 15 feet whose value has not yet been determined.

The phosphate deposits of South Carolina are classified into river rock and land rock, the river rock, which is found in the beds of rivers, having been washed into them from the original land beds.

The river rock has been worked extensively and with considerable profit, for the reason that it is obtained by the simple and cheap process of dredging, which at the same time washes the rock free from adhering impurities. The dredging scoops are massive in construction in order to break through the stratum containing the nodules of phosphate rock. The boats are held in position by four "spuds," or strong, square iron-tipped poles, one at each corner. The nodules are thrown from the scoop into the washer which is generally on a lighter moored alongside of the dredge. Various kinds of washers are used, the one in common practice consisting of a truncated iron cone with perforated sides revolving on a horizontal axis and furnished on the inside with steel spirals like the grooves in a rifle barrel. The nodules are dumped by the dredge into the small end of the cone, heavy streams of water are introduced through both ends and the cone rotated; the washed material is discharged at the larger end of the cone and is removed by a derrick to another boat which carries it to the shore. The dredge generally used is of the ladder bucket type, which consists of a series of steel buckets connected by means of double links, the whole forming an endless chain which moves over drums or tumblers fixed at the ends of the ladder or frame. The higher end of the ladder is placed directly above the receiving hoppers and the lower end is supported by a tackle which allows it to be raised or lowered, according to the depth at which the work has to be done. The motive power is applied at the upper end by means of friction gear, so that any undue strain will not break the machinery. The ladder bucket dredge in the phosphate field ordinarily does not operate at depths greater than from 20 to 25 feet. Occasionally, for depths greater than 20 feet and up to 50 and 60 feet, a clam-shell bucket dredge is used, consisting of a contrivance of 4 or 6 iron claws which open as they are lowered and close forming a bucket as they ascend. The bucket, generally of about 1 cubic yard capacity, is operated from a swinging crane covering a radius of 25 feet in front of the scow; the material is delivered at a height of 14 feet above the deck into the receiving hoppers which feed into the washers. The cost of operating a clam-shell bucket dredge is from four to five times that of the ladder bucket dredge.

Both the rock and nodules from the river and land deposits occur in very irregular masses or blocks of extremely hard conglomerate of variegated colors, which weigh from half an ounce up to more than a ton.

The mean specific gravity of the material is 2.4, and the rock is perforated with a network of very small holes, the work of innumerable crustacea, now filled with sands and clays from the overlying strata. Sometimes the nodules are quite smooth or even glazed as if worn by water; in other cases they are rough or jagged.

The average analysis of South Carolina rock may be taken as follows:

		Per cent.
Tricalcic phosphate	$Ca_3(PO_4)_2$	59.63
Calcium carbonate	$CaCO_3$	8.68
Magnesium carbonate	$MgCO_3$	0.73
Iron and aluminum oxides	Fe_2O_3 and Al_2O_3	6.60
Sulphuric acid	H_2SO_4	4.80
Calcium fluoride	CaF_2	
Water and loss on ignition	H_2O	8.00
Silica and undetermined	SiO_2	11.56

The land rock occurs chiefly in the vicinity of Charleston, while the river rock is confined to the Coosaw river and other streams in the vicinity of Beaufort. The land rock contains from 57 to 60 per cent of tricalcic phosphate, but has also a higher percentage of iron and alumina than the river rock. That portion of the river rock which is low in iron and alumina is mainly shipped abroad.

The excellent quality of the South Carolina product, together with the favorable shipping conditions, place the production on a permanent basis, and the supply of reserve rock known at the beginning of the present decade is calculated to furnish a supply at present rate of consumption for thirty-five years to come. In recent years there has been a slight decrease in the annual production of river rock. The methods of mining and preparation have not changed materially during the past decade except that steam shovels are replacing hand labor for the removal of the overburden and the mining of the land rock. With regard to land rock, Francis Wyatt describes the method of treating it in order to make it marketable as follows: (1) mining or excavating, (2) washing to remove sand and other sterile impurities, and (3) drying in kilns to drive off the contained moisture.

Taking these in their order, it is customary to establish a trunk railroad, starting at the river front or on the bank of some convenient stream, and passing through the center of the property to be exploited. Alternate laterals can be run off at right angles from any portion of this main line, at a distance of say 500 feet, in conformity with the nature of the ground. Between and parallel to these laterals a ditch or drain is dug to a depth extending from 4 to 5 feet below the phosphate strata. From this main drain the excavators start their lines at right angles to the laterals, commencing at one end of the field and digging trenches 15 feet wide and 500 feet long, the work being so arranged that the men are stationed at intervals of 6 feet. Every man is supposed to dig out, daily, a pit 6 feet long, 15 feet wide, and down to the phosphate rock. The overlying material is thrown out to the left-hand side of the trench. The phosphate itself is thrown out to the right and taken in wheelbarrows to the railroad cars which pass at either end of the trench. The water drains from the trenches into the underlying ditch, and is thence pumped out by means of a steam pump worked by a locomotive engine. The pump and the engine are secured to connected railway platforms, and run along the railroad track from one ditch to another as occasion requires.

The cars loaded with the crude phosphatic material dug out of the pits are run down to the washing apparatus, which is constructed at an elevation of 30 feet from the ground, and generally consists of a series of semicircular troughs from 20 to 30 feet long set in an iron framework at an incline of about 20-inch rise in their length. Through every trough passes an octagonal iron-cased shaft provided with blades so arranged and distributed as to form a screw with a twist of 1 foot in 6, which forces the washed material upward and projects the fragments against each other. The phosphate-laden cars are hauled up an incline and their contents dumped into the bottom trough, where the phosphate encounters one or more heavy streams of water, pumped up by a steam pump. This water does not run off at the bottom, but overflows at the higher end near where it enters. When sufficiently washed the material is pushed out upon a half-inch mesh screen, the small débris being received on oscillating wire tables below.

The phosphate is now ready for kilning or drying, and of all the methods hitherto adopted for this important process, that of simple roasting in an ordinary kiln, such as is generally used in the manufacture of bricks, is said to have been found at once the most rapid, effective, and economical. The rock pile is built on layers of pine wood, and owing to its content of a considerable quantity of organic matter it readily lends itself to combustion and requires but a short time to become quite red hot. The kilns are made sufficiently large and are so arranged as to allow free passage to a train of cars, which, running on the main line of railroad, can be loaded in the kiln, run down to the landing place, and discharged directly into the barges or boats on the river.

The total production of phosphate rock in South Carolina, based on marketed output, from 1867 to and including 1902, as reported by the United States Geological Survey, is: Land rock, 6,702,139 long tons; river rock, 3,930,362 long tons; total, 10,632,501 long tons.

Tennessee.—Although the presence of phosphatic nodules in the Chattanooga shale had been known for several years, it was not until 1893 that the industry was started in Tennessee. The deposits are in Hickman and Lewis counties in the central part of the state, but in few places only are they of sufficient quantity and richness to admit of profitable working. The phosphates are classified according to color into blue, brown, and white. The blue rock deposits began to be developed in 1894 in Hickman and Lewis counties over an area of 10 by 20 miles, the principal deposits being adjacent to Swan Creek valley. The great drawback to the exploitation of the blue rock was the distance of the field from the railroad, being 20 miles away; this objection, however, might have been overcome, but the later discovery of the high-grade, easily-moved, brown phosphate rock near Mt. Pleasant, Maury county, 56 miles from Nashville, having direct railroad transportation to the market, reduced the mining of blue rock to inconsiderable proportions. The blue rock occurs in horizontal beds overlying and conforming to the country limestone; the workable beds average 18 inches in thickness and outcrop only where the streams have cut through the overlying strata. In a few cases it can be mined in open cuts by stripping the overburden, but the great bulk of the work must be mined under cover. With an 18-inch seam the mining cost, though high, is offset by the fact that the rock is sufficiently pure to be used without preliminary washing or screening; in fact it is stated to be the only deposit of phosphate yet found in the United States that can be mined and shipped without preliminary treatment. The average composition of the blue rock shows 70 per cent of tricalcic phosphate and from 2.5 to 3 per cent of iron and aluminum oxides. On account of its location away from the railroads the consumption of blue rock is local. With this blue rock occurs a so-called brown rock containing from 74 to 75 per cent of tricalcic phosphate and from 5 to 6 per cent of iron and aluminum oxides.

The general practice of mining is to strip the overburden by hand labor and to quarry the rock in lumps, or to run drifts into the deposit and remove the rock by the ordinary pillar and stall system. Should the material overlying the phosphate rock be such that only a little timbering is required, it will not ordinarily pay to remove the overburden unless it is less than 10 feet in thickness. Ordinarily the stripping of the overburden is a simple matter for the reason that most of the phosphate rock deposits outcrop on a hillside. Generally the rock is crushed to pass through a 2-inch ring and is then treated in a revolving one-quarter-inch mesh screen in order to remove adhering clay and sand; the screened material is ground to from 60 to 80 mesh size and sold for direct use by the farmer or to small superphosphate manufacturers. The rock as it comes from the deposit is comparatively dry and contains on an average more than 60 per cent tricalcic phosphate.

Prior to 1896 the bulk of the production was obtained from the blue rock district where the mines have been developed to a considerable extent. The district was handicapped by long wagon haulage and comparatively costly underground work.

The Mt. Pleasant rock occurs over an area of from 3 to 4 miles north and south and from 6 to 8 miles east and west. There are two varieties—the soft, which constitutes the bulk of the supply, and the hard, which is of minor importance. The soft rock when dry varies in color from grayish or reddish brown to cream white, and occurs in plates of various thickness or size, rarely exceeding 2 or 3 feet in diameter. The plates are closely packed together into a fairly regular stratum which is not uniform in thickness and often sinks into depressions of the underlying limestone. The overburden averages 3 feet in thickness, except in the eastern part of the field where it is too thick in many places to admit of successful mining. The rock is of loose and porous texture and is readily ground when dry.

Two classes of product are made, known locally as domestic and export. The run of mine after the removal of the export lumps, is washed, kiln dried, crushed, and screened, the small particles and dust which pass through forming the domestic product, while the lumps constitute that exported. The export grade is guaranteed 78 per cent of tricalcic phosphate with a maximum of 4 per cent of iron and aluminum oxides; the domestic product is 75 per cent and 5 per cent of these components, respectively.

The hard rock is compact, heavy, oolitic in structure, yellow white in color, and occurs like the blue rock in a well-defined stratum of about two feet in thickness. It is of high grade, but occurs in small quantities. The Mt. Pleasant rock contains no pyrite, but little fluorite and usually a high content of tricalcic phosphate. Washing is necessary in order to remove the iron and aluminum oxides present in the crude rock as it comes from the mines. The mining at Mt. Pleasant is all open-cutwork. From 8 to 9 feet of overburden is removed by hand or with scrapers and the rock removed with pick and bar, no explosive being necessary. Usually the mined rock is dried, under sheds on a cribwork of cord wood, which is fired, yielding a thoroughly dry product. The dry rock is then crushed, screened, and stored or shipped. The high grade material is obtained chiefly from Mt. Pleasant and vicinity, while lower grade deposits exist in Hickman, Giles, and Sumner counties. For the former class of rock there is a good export market, but the low grade rock is consumed mostly at home.

The white rock deposits are in Perry county, the largest development being at Toms creek; it is far from the railroads, but is within 4 miles of the Tennessee river, which affords water transportation. The rock closely resembles Florida land rock in appearance and occurs with chert in pockets of variable size. Selected samples show a high content of tricalcic phosphate and low iron and aluminum oxides. On account of its unfavorable location but little work has been done on this property. White rock is found in other localities in Tennessee, but so far the deposits are of little, if any, importance.

Other states.—The geological survey of Alabama has examined several well-defined deposits, the chief one being the Hamburg bed in Perry county, which is part of a formation extending nearly across the state, although at only one or two points is the material of sufficient richness to make it of importance. The Coatopa bed in Sumter county has been traced for some distance. The Snow Hill bed in Wilcox and Marengo counties carries a higher percentage of tricalcic phosphate than either of the other deposits and holds out more promise of commercial value than any other in the state. There has been no production of phosphate rock in Alabama since 1900, in which year 334 long tons, valued at $534, were produced.

In Arkansas phosphate rock has been found in the counties of Independence, Stone, Izard, Baxter, Marion, Searcy, and Newton, in the northern part of the state, but little prospecting has been done, owing to the distance of the deposits from the railroads. The majority of the samples analyzed prior to 1902 showed a low content of tricalcic phosphate and were high in iron and aluminum oxides. In 1902 a large fertilizer plant was built near Batesville, on the White River Railroad, which was being extended to the mines. Mining operations have been begun in a layer of phosphate rock containing from 50 to 80 per cent of tricalcic phosphate and less than 3 per cent of iron and aluminum oxides. The deposits promise to be of considerable extent and richness, and they will doubtless be developed as soon as the railroad has been completed.

A deposit of phosphate rock has been reported near San Diego, Cal., but the samples sent east showed a small proportion of phosphoric acid and a large content of calcium carbonate.

In Georgia, according to S. W. McAllie, the only commercially important phosphate deposit is near Boston, Thomas county, which was discovered in 1889. The phosphate occurs in nodules of a size ranging from 1 inch to 1 foot in diameter, scattered promiscuously through a reddish sandy clay overlying an irregularly eroded surface of limestone. In addition to the nodules, which contain from 70 to 78 per cent of tricalcic phosphate, there is also a small proportion of soft phosphate rock. A few carloads of rock were produced in 1889, but the work was abandoned on account of the small quantity of rock available and the great thickness of the overburden.

A small quantity of phosphate rock is mined annually at the shell-rock quarry, Castle Hayne, near Wilmington, N. C. The state owns the mines, and in 1897 proposed to work them with convict labor. In 1898 a land and improvement company was organized to take over the property under contract with the state. During recent years the entire product, which is of very low grade, has been used solely for macadamizing the streets of Wilmington.

The phosphate mines at Ross Farm, Juniata county, Pa., on the Tuscarora Valley Railroad, are operated by a fertilizer company, which erected a large plant for the manufacture of acid phosphate in 1898. The average rock is of low grade, but the good rock, containing more than 50 per cent of tricalcic phosphate, can be easily separated from that of poor grade. The phosphate beds dip steeply into the mountain, and the rock can be delivered at the works, 300 yards distant, at a very low cost.

In Virginia the occurrence of deposits of hard-rock phosphate was reported in Nelson county in 1893 and in Rockbridge county in 1894. An analysis of samples showed that the material was of high grade, but the deposits examined were so inaccessible and small that the rock could not be mined at a profit.

TABLE 6.—DETAILED SUMMARY: 1902.

	United States.	Florida.	South Carolina.	Tennessee.	All other states and territories.[1]
Number of mines or quarries	115	61	10	40	4
Number of operators	87	36	10	37	4
Character of ownership:					
Individual	18	7		9	2
Firm	13	5	1	7	
Incorporated company	56	24	9	21	2
Salaried officials, clerks, etc.:					
Total number	391	192	80	115	4
Total salaries	$355,204	$206,108	$65,401	$82,125	$1,570
General officers—					
Number	64	32	9	23	
Salaries	$88,473	$53,000	$11,900	$23,573	
Superintendents, managers, foremen, surveyors, etc.—					
Number	253	118	61	71	3
Salaries	$213,983	$124,050	$45,221	$43,462	$1,250
Foremen below ground—					
Number	1	1			
Salaries	$275	$275			
Clerks—					
Number	73	41	10	21	1
Salaries	$52,473	$28,783	$8,280	$15,090	$320
Wage-earners:					
Aggregate average number	5,971	2,866	1,498	1,597	10
Aggregate wages	$1,930,093	$996,801	$435,553	$493,809	$3,930
Above ground—					
Total average number	5,901	2,858	1,498	1,535	10
Total wages	$1,906,293	$994,301	$435,553	$472,509	$3,930
Engineers, firemen, and other mechanics—					
Average number	513	320	156	36	1
Wages	$278,908	$180,982	$76,177	$21,269	$480
Miners or quarrymen—					
Average number	4,313	2,075	947	1,283	8
Wages	$1,312,379	$663,424	$258,537	$387,068	$3,350
Boys under 16 years—					
Average number	36	16		19	1
Wages	$6,106	$2,749		$3,257	$100
All other wage-earners—					
Average number	1,039	447	395	197	
Wages	$308,900	$147,146	$100,839	$60,915	
Below ground—					
Total average number	70	8		62	
Total wages	$23,800	$2,500		$21,300	
Miners—					
Average number	69	8		61	
Wages	$23,600	$2,500		$21,100	
Boys under 16 years—					
Average number	1			1	
Wages	$200			$200	
Average number of wage-earners at specified daily rates of pay:					
Engineers—					
$1.00 to $1.24	5	2	3		
$1.25 to $1.49	5	1	3		1
$1.50 to $1.74	52	34	16	2	
$1.75 to $1.99	3	2	1		
$2.00 to $2.24	47	34	1	12	
$2.25 to $2.49	24	21		3	
$2.50 to $2.74	20	10	9	1	
$2.75 to $2.99	1	1			
$3.00 to $3.24	11	2	9		
Engineers—Continued.					
$3.50 to $3.74	2	1	1		
$4.00 to $4.24	2	1	1		
$4.25 and over	1		1		
Firemen—					
$0.75 to $0.99	14		14		
$1.00 to $1.24	76	43	32	1	
$1.25 to $1.49	37	34	3		
$1.50 to $1.74	27	26	1		
$1.75 to $1.99	3	2	1		
$2.00 to $2.24	7	3		4	
$2.25 to $2.49	1	1			
$2.50 to $2.74	4		4		
Machinists, blacksmiths, carpenters, and other mechanics—					
$0.50 to $0.74	1		1		
$0.75 to $0.99	20		19	1	
$1.00 to $1.24	8		8		
$1.25 to $1.49	28	25	3		
$1.50 to $1.74	25	18	3	4	
$1.75 to $1.99	4	2	2		
$2.00 to $2.24	35	26	1	8	
$2.25 to $2.49	7	7			
$2.50 to $2.74	29	12	17		
$3.00 to $3.24	6	4	2		
$3.50 to $3.74	1	1			
$3.75 to $3.99	1	1			
$4.00 to $4.24	1	1			
$4.25 and over	5	5			
Miners or quarrymen—					
$0.50 to $0.74	6	1	5		
$0.75 to $0.99	1,010	332	556	122	
$1.00 to $1.24	2,990	1,547	302	1,140	1
$1.25 to $1.49	226	72	71	76	7
$1.50 to $1.74	126	115	5	6	
$1.75 to $1.99	1		1		
$2.00 to $2.24	7	6	1		
$2.25 to $2.49	1	1			
$2.50 to $2.74	2	1	1		
$2.75 to $2.99	2	2			
$3.00 to $3.24	4		4		
$3.50 to $3.74	1	1			
$3.75 to $3.99	2	2			
$4.00 to $4.24	2	2			
$4.25 and over	2	1	1		
Timbermen and track layers—					
$0.75 to $0.99	10		10		
$1.00 to $1.24	100	100			
$1.75 to $1.99	1		1		
Boys under 16 years—					
Less than $0.50	7	6			1
$0.50 to $0.74	27	7		20	
$0.75 to $0.99	2	2			
$1.00 to $1.24	1	1			
All other wage-earners—					
Less than $0.50	45		44	1	
$0.50 to $0.74	55		54	1	
$0.75 to $0.99	232	33	189	10	
$1.00 to $1.24	476	303	96	177	
$1.25 to $1.49	82	77	1	4	
$1.50 to $1.74	20	19		1	
$1.75 to $1.99	13	12		1	
$2.00 to $2.24	5	3		2	

[1] Includes operators distributed as follows: Arkansas, 1; New Mexico, 1; Ohio, 1; and Pennsylvania, 1.

TABLE 6.—DETAILED SUMMARY: 1902—Continued.

	United States.	Florida.	South Carolina.	Tennessee.	All other states and territories.
Average number of wage earners employed during each month:					
Men 16 years and over—					
January	5,562	2,857	1,531	1,167	7
February	5,336	2,739	1,517	1,073	7
March	5,521	2,745	1,529	1,240	7
April	5,841	2,794	1,621	1,419	7
May	5,944	2,838	1,492	1,607	7
June	6,468	2,873	1,422	2,166	7
July	6,335	2,847	1,481	1,994	13
August	6,322	2,876	1,594	1,833	19
September	6,403	2,866	1,556	1,968	13
October	6,081	2,942	1,432	1,700	7
November	5,777	2,899	1,388	1,483	7
December	5,718	2,921	1,418	1,374	7
Boys under 16 years—					
January	30	10	....	19	1
February	30	10	....	19	1
March	30	10	....	19	1
April	42	21	....	20	1
May	41	21	....	19	1
June	42	21	....	20	1
July	43	22	....	20	1
August	42	21	....	20	1
September	39	18	....	20	1
October	39	18	....	20	1
November	33	10	....	22	1
December	33	10	....	22	1

	United States.	Florida.	South Carolina.	Tennessee.	All other states and territories.
Contract work:					
Amount paid	$157,402	....	....	$157,402	....
Number of employees	306	....	....	306	....
Miscellaneous expenses:					
Total	$430,475	$283,149	$65,157	$81,882	$287
Royalties and rent of mine and mining plant	$212,350	$120,143	$38,336	$53,751	$120
Rent of offices, taxes, insurance, interest, and other sundries	$218,125	$163,006	$26,821	$28,131	$167
Cost of supplies and materials	$799,411	$542,322	$162,806	$93,742	$541
Product:					
Quantity, long tons	1,548,720	786,115	327,557	432,603	2,445
Value	$4,922,943	$2,655,163	$950,208	$1,309,172	$8,400
Power owned:					
Total horsepower	14,229	9,529	3,070	1,410	220
Engines—					
Steam—					
Number	282	192	70	18	2
Horsepower	13,974	9,359	3,070	1,325	220
Water wheels—					
Number	1	1	....	....	....
Horsepower	170	170	....	....	....
Other power—					
Number	2	....	....	2	....
Horsepower	85	....	....	85	....
Electric motors—					
Number	9	9	....	....	....
Horsepower	500	500	....	....	....

SULPHUR AND PYRITE

SULPHUR AND PYRITE.

By Joseph Struthers, Ph. D.

The statistics for the sulphur and pyrite industries have been united in the present discussion in order not to disclose the operations of 1 company engaged in producing sulphur. Table 1 is a summary of the combined statistics for these 2 industries in 1889 and 1902, and of the statistics of pyrite alone for 1880, no returns for sulphur mining having been made for that year. The expansion of domestic production to meet the increasing demand for sulphur and sulphuric acid is clearly indicated.

Table 1.—*Comparative summary: 1880 to 1902.*

	1902	1889	1880
Number of mines	23	2	1
Number of operators	18	(1)	1
Salaried officials, clerks, etc.:			
Number	54	(2)	(1)
Salaries	$49,890	$5,512	(1)
Wage-earners			
Average number	970	240	6
Wages	$338,870	$64,789	$1,800
Contract work	$3,567	$23,103	(1)
Miscellaneous expenses	$39,118	$30,262	(1)
Cost of supplies and materials	$217,262	$13,700	$365
Product[3]			
Quantity, long tons	207,874	106,100	2,240
Value	$947,089	$209,969	$5,000

[1] Not reported.
[2] Not reported separately.
[3] Includes in 1902, 11,483 tons of pyrite, valued at $29,420, produced as a by-product of coal mining.

For the twenty-two years covered, the table shows an increase in production of over one-hundredfold, and in value of nearly one hundred and ninety fold. When the total amount of sulphur consumed (as sulphur, not including pyrite) is taken into consideration, the amount of the domestic production in 1902 was not relatively large, but the steady increase indicates the substantial nature of the industry. In 1880 the industry was small—only 1 pyrite mine with a product valued at $5,000 being reported, but in 1889 the value of the production of sulphur and pyrite was $209,969. This increased to $947,089 in 1902. The growth from 1880 to 1889 was greater proportionately, but that from 1889 to 1902 was larger in absolute amount.

Three sulphur mines were reported idle in 1902—1 in Colorado and 2 in Utah; and 5 pyrite mines—1 each in Alabama and Ohio, and 3 in Virginia. At 1 sulphur mine in Texas development work was reported.

Capital stock of incorporated companies.—Of the 18 operators in the United States in 1902, 14 were organized as incorporated companies. The details of their capitalization are shown in Table 2.

Table 2.—*Capitalization of incorporated companies: 1902.*

	United States	Virginia	All other states.
Number of incorporated companies	14	2	[1] 12
Number reporting capitalization	12	2	[2] 10
Capital stock:			
Total authorized—			
Number of shares	46,000	12,500	33,500
Par value	$4,260,000	$1,250,000	$3,010,000
Total issued—			
Number of shares	38,850	7,500	31,350
Par value	$3,545,000	$750,000	$2,795,000
Dividends paid	$2,400	....	$2,400
Common—			
Authorized—			
Number of shares	42,500	12,500	30,000
Par value	$3,910,000	$1,250,000	$2,660,000
Issued—			
Number of shares	37,500	7,500	30,000
Par value	$3,410,000	$750,000	$2,660,000
Dividends paid	$2,400	....	$2,400
Preferred—			
Authorized—			
Number of shares	3,500	....	3,500
Par value	$350,000	....	$350,000
Issued—			
Number of shares	1,350	....	1,350
Par value	$135,000	....	$135,000

[1] Includes companies distributed as follows: Alabama, 1; California, 2; Louisiana, 1; Massachusetts, 1; Missouri, 1; Nevada, 1; New York, 1; Ohio, 3; Washington, 1.
[2] Includes companies distributed as follows: Alabama, 1; Louisiana, 1; Massachusetts, 1; Missouri, 1; Nevada, 1; New York, 1; Ohio, 3; Washington, 1.

These companies reported a total capital stock issued of a par value of $3,545,000. This was made up of 37,500 shares of common stock, 88 per cent of the number authorized, having a par value of $3,410,000, which is 87 per cent of the total par value of the $3,910,000 authorized; and 1,350 shares of preferred stock having a par value of $135,000, these amounts being each 90 per cent of the number of shares and total value of the preferred capital stock authorized. There was no bonded indebtedness.

Employees and wages.—The average number of wage-earners employed each month during 1902 is shown in Table 6. The employment was comparatively steady. The average number of wage-earners for the entire year was 970. The highest monthly average, 1,059, reported in July, exceeds this by only 89, and the lowest, reported in December, falls short of it by 151, a total variation of 240, or 24.8 per cent of the yearly average. Child labor constituted only 13.4 per cent of the whole.

Table 6 shows also the average number of wage-earners employed at specified daily rates of pay during 1902.

The rate group comprising the greatest number of wage-earners is that from $1 to $1.24 per diem, 30 per cent of the entire number being included within these rates. Of the employees, 205, or 21.1 per cent, received from $1.25 to $1.49 per day; 662, or 68.2 per cent got between $1 and $1.74 per day; 146, or 15 per cent of the total, were employed at a rate of $2 or more, and 117, or 12.1 per cent, received less than $1 per diem. Of the 970 wage-earners, 429, or 44.2 per cent, were employed below ground. Miners and quarrymen numbered 301, or 31 per cent, and 110, or 36.5 per cent of these, received from $1.25 to $1.49 per day, the remainder being distributed mostly among the higher rate groups, 6 receiving from $3 to $3.24. "All other wage-earners" numbered 405, or 41.8 per cent, their greatest concentration, 48.1 per cent, being in the rate group from $1 to $1.24.

Mechanical power.—The primary power reported for the sulphur and pyrite industry aggregated 6,305 horsepower. Of this 5,915 horsepower was generated by steam, 20 by gas or gasoline, 50 by rented waterpower, and 320 by air compressors. Two electric motors, having a capacity of 80 horsepower, were also reported.

Production.—In the following table the figures for the domestic production and the imports of sulphur and pyrite are given, so far as obtainable, for the years 1880 to 1902. The statistics for the two minerals are presented separately except for 1902, a combination for that year being necessary to avoid disclosing the operations of a company engaged in producing sulphur. The quantity of sulphur displaced by the use of pyrite is also shown.

TABLE 3.—ANNUAL DOMESTIC PRODUCTION, IMPORTS, AND TOTAL CONSUMPTION OF SULPHUR AND OF PYRITE, WITH PERCENTAGE DOMESTIC PRODUCTION IS OF TOTAL CONSUMPTION, AND QUANTITY OF SULPHUR DISPLACED BY PYRITE: 1880 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	SULPHUR.						PYRITE.						Quantity of sulphur displaced by use of pyrite (long tons).²
	Total consumption (long tons).	Domestic production.			Imports.		Total consumption (long tons).	Domestic production.			Imports.¹		
		Quantity (long tons).	Value.	Per cent of total consumption.	Quantity (long tons).	Value.		Quantity (long tons).	Value.	Per cent of total consumption.	Quantity (long tons).	Value.	
1880	88,655	536	$21,000	0.6	88,119	$2,034,999							
1881	105,802	536	21,000	0.5	105,266	2,720,266							
1882	98,258	536	21,000	0.6	97,722	2,636,524		12,000	$72,000				
1883	96,627	893	27,000	0.9	94,734	2,296,085		25,000	137,500				
1884	105,862	446	12,000	0.4	105,416	2,255,331	51,710	35,000	175,000	67.7	16,710	$50,632	
1885	97,712	638	17,875	0.7	97,074	1,951,354	55,078	49,000	220,500	89.0	6,078	18,577	
1886	120,099	2,232	75,000	1.9	117,867	2,250,605	56,605	55,000	220,000	97.2	1,605	9,771	
1887	99,924	2,679	100,000	2.7	97,245	1,700,723	68,578	52,000	210,000	75.8	16,578	49,661	
1888	98,407				98,407	1,586,519		54,331	167,658				
1889	136,360	402	7,850	0.3	135,968	2,070,461		93,705	202,119				
1890	162,789				162,789	2,767,731		99,854	273,745				
1891	118,258	1,071	39,600	0.9	117,187	2,683,971	207,184	106,536	338,880	51.4	100,648	592,141	93,233
1892	103,522	2,400	80,640	2.3	101,122	2,100,026	252,147	109,788	305,191	41.9	142,359	567,990	117,966
1893	106,894	1,071	42,000	1.0	105,823	1,909,961	270,711	75,777	256,552	28.0	194,934	721,699	121,920
1894	125,905	446	20,000	0.4	125,459	1,708,617	279,486	105,940	363,134	39.8	163,546	590,905	121,209
1895	123,703	1,607	42,000	1.3	122,096	1,613,754	289,981	99,549	322,845	34.3	190,435	673,812	130,493
1896	143,976	4,696	87,200	3.3	139,280	2,172,629	315,651	115,483	320,163	36.6	200,168	618,395	142,043
1897	143,936	2,031	45,590	1.4	141,905	2,454,073	402,747	143,201	391,541	35.6	259,546	747,419	181,236
1898	165,575	1,071	32,960	0.7	164,504	3,069,924	446,137	193,364	593,801	43.3	252,773	717,813	200,762
1899	145,846	4,313	107,500	3.0	141,533	2,523,233	444,602	174,734	543,249	39.3	269,868	1,077,061	200,071
1900	170,843	3,147	88,100	1.8	167,696	2,940,888	527,099	204,615	749,991	38.8	322,484	1,065,121	237,195
1901	182,076	6,866	223,430	3.8	175,210	3,287,906	638,531	234,825	1,024,449	36.8	403,706	1,415,149	287,339
1902	(³)	(³)	(³)	(³)	174,939	3,283,309	³648,237	³207,874	³917,049		440,363	1,650,852	(³)

[1] Previous to 1884 classed among sulphur ores; 1887 to 1891 classed among other iron ores; since 1891 includes iron pyrite containing 25 per cent or more of sulphur.

[2] Estimated on basis of 45 per cent sulphur content.

[3] The statistics of the domestic production and total consumption of sulphur are combined with those of pyrite to avoid disclosing the operations of a company producing sulphur.

The quantity of sulphur produced each year in this country has been a relatively small part of the total consumption of the commodity. In no year during the period covered by the table has this proportion exceeded 3.8 per cent, but a comparison of the fluctuation makes it evident that this proportion tends to increase. The imports have increased from 88,119 long tons in 1880 to 174,939 long tons in 1902.

Practically all the pyrite consumed in 1882 was of domestic production, but in 1901 this source yielded only 36.8 per cent of the total. Owing to trade conditions the foreign pyrite can be more profitably utilized than can the domestic ore. Hence the imports have constantly grown until they now form almost two-thirds of the total consumption.

The recovery of the sulphur content of pyrite has steadily encroached upon the field formerly occupied almost exclusively by sulphur. Estimated on an average sulphur content of 45 per cent, the quantity of sulphur displaced by the use of pyrite has grown from

93,233 long tons in 1891 to 287,339 long tons in 1901. This latter figure exceeds the domestic production of sulphur by 280,473 long tons.

Imports of sulphur.—Table 4 shows the importation of sulphur into the United States for 1900, 1901, and 1902, the exporting countries, and the customs district at which the sulphur was entered.

TABLE 4.—IMPORTS, BY COUNTRIES AND BY CUSTOMS DISTRICTS, INTO THE UNITED STATES, OF CRUDE SULPHUR OR BRIMSTONE, FOR THE FISCAL YEAR ENDING JUNE 30: 1900 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

	1900		1901		1902	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
COUNTRY.						
Total	155,399	$2,711,912	159,711	$2,875,104	187,480	$3,582,884
Canada			933	24,957	776	18,631
England	7,425	155,882	7,184	156,205	7,681	161,387
Italy	138,011	2,369,037	139,192	2,474,684	163,571	3,111,971
Japan	9,958	186,847	11,798	219,193	15,448	290,826
Other countries	5	146	4	65	4	69
DISTRICT.						
Total	155,399	2,711,912	159,711	2,875,104	187,480	3,582,884
Baltimore, Md	12,798	213,893	9,040	153,664	12,137	225,904
Boston and Charlestown, Mass	10,023	203,014	11,048	217,274	12,124	251,366
Champlain, N. Y						
New Orleans, La	1,000	16,111	2,213	54,694		
New York, N. Y	85,885	1,467,947	89,756	1,585,084	100,109	1,891,554
Philadelphia, Pa	7,448	120,284	11,100	185,319	16,719	304,777
Portland, Me	24,880	486,692	20,039	363,473	30,032	596,931
San Francisco, Cal	8,257	152,335	9,359	172,176	10,497	200,255
Savannah, Ga	751	13,675	1,000	18,190		
Vermont			439	12,285		
Willamette, Oreg	1,630	33,134	2,067	40,515	3,475	63,096
All other	2,747	54,827	3,630	72,430	2,387	48,501

Relative production of sulphur by various countries.—In order to show the production of sulphur by the different countries of the world, the following table has been compiled from data gathered by the United States Geological Survey. This table indicates that nearly 90 per cent of the world's production of sulphur is obtained from Italy.

TABLE 5.—*World's production of sulphur: 1899, 1900, and 1901.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

COUNTRY.	1899		1900		1901	
	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
Total	645,044	$10,946,838	641,809	$10,809,041	636,761	$11,149,937
United States	4,383	107,500	3,189	88,100	6,976	223,430
Austria[1]	555	1,526	862	2,256	4,911	12,107
France[1]	11,744	28,884	11,551	26,427	7,000	16,400
Germany	1,023	32,000	1,445	31,000	983	29,250
Greece	1,237	22,266	891	16,038	3,212	67,290
Hungary	116	3,600	123	3,820	137	3,847
Italy	554,638	10,392,415	544,119	10,212,903	563,096	10,731,192
Japan	10,235	211,735	14,435	298,660	(2)	(2)
Russia	451	9,412	(2)	(2)	(2)	(2)
Spain	1,100 [1]58,922	31,350 102,150	750 [1]61,364	18,000 109,947	610 [1]49,856	18,115 59,306
Sweden			70	1,890		

[1] Crude rock.

[2] Statistics not yet reported.

A detailed summary of the industry is given in Table 6.

DESCRIPTIVE.

SULPHUR.

Sulphur has been known to mankind from the earliest records of history. It is one of the most important elements that comprise the earth's crust, and occurs in a free or uncombined state in many countries, forming the mineral sulphur, more commonly known in commerce as brimstone.

Physical and chemical characteristics.—The element is insoluble in water and nearly so in alcohol and ether, but is quite soluble in carbon disulphide, petroleum, and benzine. It burns in air with a blue flame, and is oxidized into sulphur dioxide or sulphurous acid. It exists in two distinct crystalline forms, and also as an amorphous variety. These modifications are characterized by differences in specific gravity, in solubility in various liquors, and in many other respects.

Sulphur is a pale-yellow, brittle, crystalline solid, with a resinous luster, is almost tasteless, and emits a peculiar characteristic odor when rubbed or warmed. It is a nonconductor of electricity and an extremely bad conductor of heat. When very gently warmed, even by being grasped in the hand, it may be heard to crack by the mere warmth, and will ultimately fall to pieces. At a temperature of 114.5° C. it melts into a clear amber-colored and moderately mobile liquid; on raising the temperature of this liquid, its color rapidly darkens, and at the same time it loses its mobility until at a temperature of about 230° C. the mass appears almost black, and is so viscous that it can no longer be poured from the vessel. As the temperature is still further raised the substance, while retaining its dark color, again becomes liquid, although it does not regain its former limpidity. At 448° C. the liquor boils and is converted into a pale yellowish-brown colored vapor. In cooling the same changes occur in reverse order. The atomic weight is 32. The specific gravity of ordinary octahedral sulphur is 2.05; of prismatic sulphur, 1.96.

Uses.—Sulphur is used in the preparation of sulphuric acid, in the manufacture of gunpowder, in making friction matches, in vulcanizing rubber, as an insecticide, and in medicine as a laxative, and for certain skin diseases.

Minerals of sulphur. Sulphur occurs in combination with other elements, forming the large and important groups of minerals, the sulphides and the sulphates. Of the sulphide minerals, the combinations with the metallic elements are of primary industrial importance, and, with the possible exception of the iron sulphides, they form the ores from which many of the base metals are obtained.

The principal sulphide and sulphate combinations are as shown below.

Sulphide and sulphate combinations.

COMBINATION OF ELEMENTS.	Name of mineral.	Chemical formula.
Chief sulphide minerals:		
Sulphur and iron	Pyrite	FeS_2
Sulphur and iron	Marcasite	FeS_2
Sulphur and iron	Pyrrhotite	$Fe_{11}S_{12}$
Sulphur and copper	Chalcocite	Cu_2S
Sulphur and copper and iron	Chalcopyrite	$CuFeS_2$
Sulphur and copper and iron	Bornite	Cu_3FeS_3
Sulphur and lead	Galenite (galena)	PbS
Sulphur and zinc	Sphalerite (zinc blende)	ZnS
Sulphur and silver	Argentite	Ag_2S
Less important sulphide minerals:		
Sulphur and arsenic	Realgar	AsS
Sulphur and arsenic	Orpiment	As_2S_3
Sulphur and antimony	Stibnite	Sb_2S_3
Sulphur and molybdenum	Molybdenite	MoS_2
Sulphur and mercury	Cinnabar	HgS
Sulphur and nickel	Millerite	NiS
Sulphur and tin	Tin pyrites	SnS_2
Chief sulphate minerals:		
Sulphur and calcium	Gypsum	$CaSO_4 2H_2O$
Sulphur and calcium	Anhydrite	$CaSO_4$
Sulphur and barium	Barite	$BaSO_4$
Sulphur and magnesium	Epsomite (Epsom salt)	$MgSO_4 7H_2O$
Sulphur and strontium	Celestite	$SrSO_4$
Sulphur and sodium	Thenardite (Glauber salt)	Na_2SO_4
Sulphur and lead	Anglesite	$PbSO_4$
Important artificial sulphates:		
Sulphur and copper	Copper sulphate (blue vitriol).	$CuSO_4 7H_2O$
Sulphur and iron	Iron sulphate (copperas).	$FeSO_4 7H_2O$
Sulphur and zinc	Zinc sulphate (white vitriol).	$ZnSO_4 7H_2O$

Sulphur dioxide (SO_2) is the direct combination of sulphur with oxygen and is found naturally as a minor constituent of the atmosphere, particularly near volcanoes, and over large cities, where its presence is due to the oxidation of the sulphur contained in the fuel burned.

In vegetables sulphur exists in some of the tissues of plants, although not in the woody tissues. In animals it constitutes an essential element of the blood, muscles, skin, hair, and other parts.

Hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) are evolved from volcanoes as gases, which are doubtless the products of the action of the water of the ocean which has penetrated to the interior of the volcano upon the molten metallic sulphides that exist there.

The two forms in which the sulphur is marketed are the flour, or flowers, of sulphur, which is a light powdery form of the substance caused by the condensation of sulphur vapor; and brimstone, or sulphur, which is made usually by melting this soft powder and molding the liquid thus obtained into large blocks or cylindrical rods in wooden molds.

Occurrence.—Natural deposits of sulphur are sometimes found stratified with beds of clay or rock, but they often occur as what are known as "living" beds, in which the sulphur is continuously being formed as the result of active chemical decompositions. In such a living sulphur bed the sulphur is produced by the direct action of sulphurous gases, especially hydrogen sulphide (H_2S) and sulphur dioxide (SO_2), which in the presence of moisture (H_2O) react and form water (H_2O) and sulphur (S). These gases emanate in regions of active or expiring volcanoes, and form the so-called solfataras, in which the sulphur has been condensed from the vapors formed and has collected in cracks in the lava and tuffs or in the kaolin or clay formed by the corroding action of the acid vapors on the lavas.

From a commercial standpoint, especially for the manufacture of sulphuric acid, the mineral from the solfatara deposits is not regarded favorably on account of its liability to contain arsenic in the form of the minerals orpiment (As_2S_3) and realgar (AsS). Sulphur of this character has been imported from the island of Vulcano, one of the Lipari group, off the coast of Italy. A similar association of arsenic minerals has been reported in the sulphur deposits in Yellowstone National Park. Traces of selenium and tellurium, which are also objectionable in the manufacture of sulphuric acid, occur in the volcanic sulphur deposits in Japan. The only solfatara deposits of commercial importance at the present time are in southern Utah and in the island of Hokkaido, Japan.

The world's supply of sulphur is derived from two principal sources: (1) The deposits of the native mineral sulphur, which yield the sulphur or brimstone of commerce; and (2) the deposits of the sulphide minerals—pyrite, pyrrhotite, chalcopyrite, sphalerite, and other sulphides—from which is derived the sulphur dioxide gas used in the manufacture of sulphuric acid. In addition to these two natural sources of sulphur, there are several artificial products containing sulphur, chiefly in the form of sulphur dioxide gas, in sufficient quantity to admit of commercial utilization. There are also lead, copper, and other mattes from the furnace treatment of various lead and copper ores and alkali waste from chemical works engaged in manufacturing soda.

During recent years, however, several thousand tons of sulphur have been produced annually in England from the accumulated alkali waste of the Le Blanc soda process. This manufactured product is known as "chance-claus," or recovered sulphur. The process of its manufacture reproduces, in many respects, the chemical reactions by which natural sulphur is formed from gypsum.

REVIEW OF THE INDUSTRY IN THE UNITED STATES.

The development of the sulphur mining industry in the United States has been of very slow growth, owing principally to the cheapness with which the refined product can be imported from Italy. In recent years nearly the entire supply has been obtained from the enormous deposits in the island of Sicily, which supplies, as well, by far the greater part of the rest of the world's demand. The deposits of sulphur which have been worked in the United States are limited in number. The states from which, during 1902, the domestic supply of native sulphur was derived are, in the order of the quantity of their output, Louisiana, Nevada, and Utah.

The following is a brief summarization of the progress that has been made in extracting and refining the sulphur of the deposits in this country.

Louisiana.—An immense deposit of sulphur of the gypsum type occurs in Calcasieu parish, 230 miles west of New Orleans and 12 miles from Lake Charles. This is unquestionably the most accessible of the American deposits, and, in all probability, it is the richest as well. Exceptional difficulties have been encountered in developing the mine, owing to quicksand and gravel which overlie the mineral. As proved by a number of drill holes, the bed of sulphur is from 110 to 125 feet in thickness, the upper level being about 350 feet below the surface.

In the working of the Frasch process,[1] a well is sunk by a drill precisely in the same way as for petroleum.[2] This well is cased with an iron pipe 10 inches in diameter, which enters the rock overlying the bed of sulphur for a distance of 10 feet, the joint being subsequently sealed as well as possible by molten sulphur in order to exclude water. Inside the 10-inch pipe is placed one of 6-inch diameter; inside the latter, one of 3-inch diameter; and, finally, inside the 3-inch pipe, one of 1-inch diameter. The well itself is carried down to the bottom of the sulphur bed, and the 6-inch and smaller pipes are extended nearly to the bottom of the well. The inner pipes are recovered when the well is abandoned. The method of extracting the sulphur is as follows: Steam at a temperature of 330° F. is forced down the 10-inch and 6-inch pipes under a corresponding pressure. When the steam comes in contact with the sulphur (which at 284° F. becomes liquid), the latter melts and collects in the well as a thin liquid of a specific gravity of about 2. At first the molten sulphur was pumped out through the 3-inch pipe in a manner similar to that followed in pumping petroleum from a well, the working valve being formerly of aluminum, which is not affected by sulphur. It was found, however, that the aluminum was not strong enough to withstand the shock of the heavy column at the change of stroke, and the method had to be abandoned. Later, the 1-inch pipe referred to above was introduced into the 3-inch pipe, and through it compressed air was forced. The bubbles of air mixed with the sulphur reduce the specific gravity of the column of sulphur and cause it to rise with rapidity. This latter method of extraction has not been entirely satisfactory, and it may have been modified or replaced by some other more efficient method. The sulphur produced is practically refined sulphur, and finds a ready sale on account of its purity and attractive appearance.

It is not practicable to ascertain precisely what occurs at the bottom of the well, but it may be assumed that as the sulphur melts out of the bed it forms a more or less pear-shaped cavity, which becomes larger and larger, until finally the increased surface exposed to the water is sufficiently great to reduce the temperature of the water below the melting point of the sulphur, while the impurities of the bed collect on the bottom and the sides of the chamber and protect the sulphur still unfused from the melting action of the heated water. If the bed of sulphur is very pure the chamber might become quite large in size, when the unsupported overlying roof would fall and allow the water to escape through the overlying beds.

Although the Frasch process is very ingenious and the inventor deserves great credit for working out the numerous details, yet its application to the deposits of sulphur has greatly injured them, since the exploitation of the deposit by shafts and the common method of underground mining has now become fraught with danger, owing to the uncertain extent of the openings from which the sulphur has been dissolved by the Frasch experiments. In view of the heavy flow of water which may be expected through certain of the strata this uncertainty is an element of great peril.

Nevada.—Sulphur occurs at Rabbit Hole Springs, 35 miles from Humboldt House, in Humboldt county. The deposit is of the solfatara type; and the sulphur, associated with gypsum, etc., fills the craters of a few extinct hot springs. The sulphur rock is in beds of considerable thickness and extent, included between limestone and magnesian rocks. The ore occurs in masses of various sizes up to several hundred pounds in weight, which are mixed with clay among heaps and layers of ashes and light gravel. The ore is mined by adits and drifts run in from the level of the wagon road, which extends entirely around the hill at a considerable elevation. All rock containing more than 8 per cent of sulphur is mined, and the product is taken to the refinery and refined in iron kettles heated by dry steam. The refined product is carried in wagons to Humboldt House and shipped thence by rail, chiefly to the powder factories and acid makers on the Pacific coast.

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[1] United States patents, Nos. 461429, 461430, and 461431 of October 20, 1891.

[2] The Mineral Industry, Vol. V, pages 514 and 515.

Utah.—The deposits which are the source of most of the sulphur mined in Utah are located in Beaver county near the Millard county line. They were known to the early pioneers, who obtained small quantities of almost pure sulphur from the numerous caves in that vicinity. Soon after the year 1870 the claims were located under the mining laws, and a small refining furnace was installed which was worked intermittently until the year 1891, when the property changed owners, and the plant was modernized and enlarged. Under the new management, the mining operations of the company have been continuous and successful. The ore is removed by open cutting, and the furnaces are worked during the summer only. Four of the six stacks in the refining plant are generally operated at a time, and about 50 tons of 20 per cent rock are treated daily, yielding the refined product in the form of roll sulphur, which is sold as such or is ground in mills to make flour sulphur.

Deposits in other states and in Alaska are thus described:

Alaska.—There are a number of sulphur deposits of the solfatara type on the volcanic islands off the coast of Alaska. The largest so far as known is on the island of Kadiak, but others are recorded on Unalaska and Akutan islands, and on an unnamed island southeast of Akun Island. The deposits have not yet been exploited beyond the prospecting stage.

California.—At Sulphur Bank, on Clear Lake, 40 miles north of San Francisco, a deposit of sulphur occurs in the white siliceous residue of a basalt flow that has been decomposed by the uprising solfatara and the sulphur deposited. Some 25 years ago this deposit contributed a small quantity to the domestic supply of the United States, but as the development work went deeper cinnabar was found, and sulphur was no longer produced. A deposit of sulphur was worked for a time in Colusa county, and a small refinery was erected, but during the past decade little, if any, sulphur has been produced in this county. The occurrence of sulphur has also been reported in other localities in California, but nowhere in sufficient quantity to warrant its extraction as a commercial product.

Idaho.—The occurrence of sulphur has been reported near Swan Lake, Custer county, and also near Soda Springs, in Bannock county. The deposits have not yet been developed to any great extent, although there was a small output in 1901.

Texas.—The sulphur deposits in the northeastern part of El Paso county have been known since 1854, when they were noticed by Prof. William P. Blake, who was then the geologist of an expedition for the survey of a railroad route from the Mississippi river to the Pacific ocean, which was made by the United States War Department. The region in which the deposits occur is from 13 to 60 miles from the railroad. The nearest railroad station, Guadalupe, on the Pecos Valley Railroad, is 42 miles north of Pecos. The sulphur occurs in the form of small crystals embedded in white gypsum, and in some instances the ore contains as much as 25 per cent of native sulphur. The area of the region thus far prospected is small, but there are other localities of promise awaiting examination.

Method of refining sulphur. It has been proposed to separate sulphur from the ore by heating it with hot air, with steam under pressure, or with superheated steam. But these methods have been unprofitable on account of the cost of fuel in those regions where sulphur occurs. Sulphur may be extracted from the ore by a solvent, such as carbon disulphide, which may be recovered afterwards, but this method necessitates an expensive plant. For some ores a treatment with a solution boiling above the melting point of sulphur has proved successful. The ore is placed in an iron basket or crate in a boiling solution of calcium chloride,[1] which boils at 125° C. The sulphur melts and flows away from the matrix of stones, etc.; passing through the meshes of the basket and falling to the bottom of the tank, it is drawn off and cast in molds. After it is melted out, the basket of hot stones is lowered into a tank of water, which is heated by the stones, while it removes the adhering calcium chloride from them. This warm water is then used to replace that lost from the boiling calcium chloride solution. This process causes no loss of sulphur as sulphur dioxide, and no nuisance is created, while a fairly pure product is obtained. The calcium chloride used is a waste product of the ammonia soda industry.

In the United States, the extraction of sulphur by means of superheated steam[2] has been tried, and an excellent quality of sulphur has been obtained without formation of any sulphur dioxide. The cost of fuel in the West, however, is an obstacle to the further development of this method. In Louisiana, as mentioned earlier in this paper, steam is forced, under pressure, through driven wells or tubes, into the sulphur deposit, which partly refines the sulphur, liquefied by the heat. The molten product is forced to the surface by the steam pressure through a small pipe inside of the steam pipe.

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[1] Vincent: Bull. Soc. Chim., 40, 528. Am. Chem. Jour., VI, 63.

[2] J. Soc. Chem. Ind., 1887, 439, 442; 1889, 696.

Generally the method of extracting the sulphur from the ore, and at the same time of partially refining it, is to treat the ore in a cylindrical or slightly conical cast-iron vessel of a capacity of about 5 tons of ore. Steam inlets are provided at the top and bottom; also a bottom valve through which the melted sulphur is withdrawn and cast into molds. The size and the form of this refining vessel depends to some extent upon the nature of the material to be treated. If the ore is porous, a higher vessel of greater capacity can be used, and with ores that increase their volume considerably from the action of the heat, the bottom of the vessel should be made of much larger cross section than the top, in order to facilitate the discharge of the spent ore after the sulphur has been extracted. The steam jets are so arranged that the melted sulphur can not accumulate at any point within the vessel except at the bottom. If properly arranged and operated the extraction of sulphur by means of superheated steam should be accomplished with the loss of not more than from 1.5 to 2 per cent of the quantity of sulphur treated.

Sulphur deposits of Italy.—Owing to the importance of the sulphur deposits of Italy, the following brief outline of the methods of mining and refining adopted in that country will be found of interest.[1]

In Sicily the sulphur mineral is disseminated through the matrix, sometimes in considerable masses of nearly pure sulphur, but usually in fine seams or grains. The methods of obtaining it are very crude and wasteful. The mines are for the most part open pits, ranging from 200 to 500 feet in depth, and the ore is carried to the surface in baskets or sacks by laborers, who ascend by inclined paths on the walls of the pit. In a few of the better mines, however, hoisting machinery is now used, but the introduction of this method has met with the determined opposition of the laborers.

The ore is generally refined in a very simple manner, the process being carried on in kilns called "calceroni." As usually constructed, these are shallow pits about 30 feet in diameter, with walls about 10 feet high, made tight with mortar. They are generally built on a hillside, and the sloping bottom is beaten smooth. The ore is arranged in the calcerone so as to leave a few vertical draft holes from top to bottom of the heap, which is fired by dropping burning brush or straw into these openings. The sulphur, which forms from 25 to 40 per cent of the ore, burns freely, and when the heap is well on fire the draft holes are closed, the calcerone covered with spent ore, and the whole left for several days. The heat given out by the burning of part of the sulphur is sufficient to melt the remainder from the gangue, and it collects in a pool near a tap hole made in the wall at the lowest point. At intervals of a few hours the melted sulphur is drawn off into molds. If the temperature rises above 180° C. (356° F.), there is a large formation of plastic sulphur, which will not flow from the tap hole. The time necessary to burn out a calcerone varies from thirty-five to eighty days, according to its size, the weather, and the nature of the impurities; for example, much gypsum retards the process, owing to the water it contains. Usually from a quarter to a third of the sulphur is lost as sulphur dioxide during the burning. As this causes much damage to vegetation in the vicinity, the burning of calceroni is prohibited during the spring and summer months.

PYRITE.

The name pyrite is derived from the Greek word *πυρίτης* meaning "of the nature of fire," and alludes to the property possessed by the mineral of producing sparks when struck with a hard substance. Specifically, the name pyrite is restricted to the isometric crystalline form of the native iron bisulphide mineral (FeS_2) containing 46.6 per cent of iron and 53.4 per cent of sulphur. The mineral marcasite is also a native iron bisulphide (FeS_2) of identically the same chemical composition as pyrite, but it occurs in crystals of the orthorhombic system of crystallization. In a general sense, pyrite includes that class of native minerals in the massive or crystalline form composed of a metallic sulphide or arsenide, or both. Iron, copper, nickel, and cobalt pyrites are the principal minerals of this class.

Occurrence.—Pyrite occurs abundantly in rocks of all geologic ages, from the oldest crystalline to the most recent alluvial deposits. In crystalline formation it usually occurs in small cubes, pyritohedrons, or in more highly modified shapes; also in irregular spheroidal nodules, and in the massive form in clay slate, argillaceous sandstone, coal formation, etc.

Uses.—Pyrite is used principally in the manufacture of sulphuric acid. Recently it has also been used in pyritic and allied smelting processes and, to some extent, in making sulphur dioxide gas for use in bleaching wood pulp. In vulcanizing rubber and in the preparation of medicinal compounds the use of pyrite is impracticable.

Deposits and mining in the United States.—The deposits of pyrite in the United States are quite numerous and widespread. The largest deposits so far discovered are at Mineral, Va., and Charlemont, Mass. Deposits are also found in Alabama, California, Georgia, Indiana, New York, and Ohio. The mineral was mined in these states in 1902. Virginia supplied nearly one-half of the total. The production in Indiana and Ohio was in the form known as "coal brasses," obtained as a by-product in the mining of coal. The total quantity so produced, however, was but a small proportion of the total output of the United States. It is not probable that the production of pyrite from this source will ever become of importance.

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[1] F. H. Thorp: Outlines of Industrial Chemistry, 1898.

There are many other deposits of pyrite in the United States, but they have not been exploited because of the impure or low-grade quality of the ore and the excessive cost of mining and of transportation both to and on the railroads leading to the centers of consumption. Some of the ores not now deemed of sufficient value to be worked for their sulphur content will eventually be profitably treated by modern methods. In the Southern states particularly are many deposits of this character, which could produce enormous amounts of sulphuric acid in this manner at prices lower than the present average prices at the seaboard. A condition which has served to retard the growth of the production of the domestic ore lies in the fact that foreign ores can be imported and accumulated at the seaboard and shipped inland in quantities sufficiently large to secure very low freight rates.

A promising prospect for the pyrrhotite ores of the South lies in the feasibility of their utilization for the manufacture of sulphuric acid. It is claimed that the sulphur contained in these ores can be so effectually removed that the residual product will be of value in the manufacture of pig iron or even of steel. For this purpose the cinders or residues from the roasting of pyrite for the manufacture of sulphuric acid have been utilized to advantage. It is well known that the residues from Spanish ores treated by the Henderson process have been sold either in the form of "fines" or "briquetting" and utilized in the manufacture of steel, but in the United States roasted pyrite residues have not yet been utilized for the manufacture of iron on account of the large percentage of sulphur remaining in them after treatment in the chemical works. If pyrite residues could be roasted so that the amount of sulphur remaining after treatment would be so small as to permit of their utilization for the manufacture of pig iron, there would result an annual saving of many thousand tons from what is now a waste product. As yet, however, the recovery of sulphur and iron from these ores is in an experimental state.

Other experiments have recently been conducted for the utilization of the by-product gases resulting from the roasting of zinc blende ores, the practicability of which has been demonstrated with financial profit at the zinc plants of Peru and Lasalle, in Illinois, and of Argentine, in Kansas. It is feasible to save from 25 to 28 per cent of the sulphur content of the zinc ores during the roasting, which yields a product containing not more than 2 per cent of sulphur. By subsequently roasting this product—cinders, as it is called—in the Chase or other type of special roasting furnace the remainder of the sulphur will be expelled, and the dead-roasted zinc ore will then be in proper condition to permit of the extraction of the zinc at very low cost. There is an immense supply of sulphur in the zinciferous sulphide ores of Arkansas, Colorado, Kansas, Kentucky, Missouri, and other states, and it is well within the range of probability that ere long the tonnage of sulphur derived from pyritiferous ores will be largely augmented by the utilization of the sulphur contained in these zinc sulphide ores.

An important factor in the development of the pyrite industry is the demand for sulphuric acid in the treatment of phosphate rock, and in the refining of petroleum. Since a chemically pure sulphuric acid is not essential for these purposes, the acid made from pyrites serves quite as well as that made from sulphur. Another field for the future extension of the utilization of the pyritiferous ores lies in the making of sulphur dioxide gas for use in bleaching wood pulp, which is the basis of the manufacture of paper by the sulphite process. Heretofore American manufacturers of paper using this process, with one or two exceptions, have been limited to the use of sulphur for making sulphur-dioxide gas, although in Europe a considerable quantity of pyrite has been thus utilized. It is quite probable that the difficulties that have heretofore existed in the way of utilizing pyrite in the bleaching of pulp will be overcome in the near future. When this becomes an accomplished fact it will open up a large field for the consumption of pyrite in New York state, and also of the lean cupriferous pyritic ores of the New England states. Where the conditions are favorable for deep mining and concentration and for shipment to the numerous paper mills of that section, constant and large supplies of sulphur will thus be guaranteed at prices much lower than can be expected from outside sources.

THE MANUFACTURE OF SULPHURIC ACID.

The manufacture of sulphuric acid is of great industrial importance, as the acid is of primary importance in the manufacture of phosphate rock fertilizers and in the refining of petroleum. It is also required in the manufacture of other acids and chemical salts, and has a very wide field in the making of alizarin dyes, artificial indigo, and many other important chemical salts. Of the immense quantities of sulphuric acid made yearly, the greater part does not appear on the market; because of the expense and difficulty of shipping it, consumers of large amounts generally make their own acid.

Until a few years ago the total quantity of ordinary sulphuric acid produced in the world had been obtained by burning crude sulphur in air, the resultant sulphur dioxide gas being then passed, together with steam and an oxidizing agent, generally nitric oxide, into lead-lined chambers, where these gases react on one another and form the dilute acid, which is subsequently purified and concentrated to the desired degree of strength. This process is called the lead-chamber process, but a newer and more satisfactory process is the "contact" process, in which the sulphur dioxide gas, in the presence of so-called "catalytic" substances (platinum sponge, platinized asbestos, iron oxide, etc.) is directly oxidized to sulphur trioxide (SO_3), which is then absorbed in water to form sulphuric acid of any degree of strength. Recently it has been found more economical in making sulphuric acid to utilize the sulphide minerals as the source of sulphur dioxide gas. In this manner the more costly brimstone is reserved for purposes other than acid manufacture, and for which the sulphide minerals would not be applicable.

The use of pyrite as a raw material in the manufacture of sulphuric acid was first proposed by an Englishman named Hill, who obtained a patent for the process in 1818. It was not until 1838, however, when the price of crude sulphur was nearly trebled by the French firm who had purchased from the Sicilian government the monopoly of the sulphur exportation from that island, that the use of pyrite by acid makers attained any importance. In the United States, which leads the world in the consumption of sulphur, this substitution of pyrite for sulphur in acid making has continued steadily during the past twenty-five years, and owing to its cheapness and widespread occurrence, pyrite has almost completely replaced the crude sulphur that was formerly used almost exclusively. This change in acid making has resulted largely from the treatment of phosphate rock by sulphuric acid, by which it is made into valuable fertilizer, and also from the use of the acid in the refining of crude petroleum. For these purposes the use of a high-grade, pure sulphuric acid is not essential. Unrefined sulphuric acid made from pyrite is generally contaminated with arsenic, and frequently with the additional impurities, copper, zinc, and selenium, but not in sufficient quantities to bar its use in preparing fertilizers or in refining the crude petroleum. The impurities, too, may be removed if desired, and a pure acid produced.

To give some idea of the large quantities of the acid consumed in these industries, it may be stated that 1 pound of acid of chamber strength is required to convert each pound of crude phosphate rock into acid phosphate or commercial fertilizer, and during 1902 over 1,500,000 long tons of the crude phosphate rock were mined. In refining crude petroleum each gallon of commercial petroleum (kerosene) requires 1 pound of sulphuric acid of a strength of 66° B. for its production, and during 1902 the output of crude petroleum in the United States amounted to over 89,000,000 barrels, each of 42 gallons capacity. In estimating the quantity of acid consumed in these two industries alone, any calculation based upon figures of production, less imports, both of crude petroleum and phosphate rock, must necessarily be tentative and not even closely approximate, for the reason that it is impracticable to ascertain the exact quantities of stock of crude material on hand at the beginning and at the close of a year. For practical purposes, however, it may be assumed that the consumption of sulphuric acid in the United States at the present time is approximately in the following proportions: For the treatment of phosphate rock, 50 per cent; for refining crude petroleum, 38 per cent; and for use in the chemical trade, 12 per cent.

In making sulphuric acid from pyrite, pieces of the mineral ranging in size from several inches in circumference to extreme fineness are burned with access of air in a furnace, of which there are many forms, each suited for some special physical or chemical characteristic of the ore. As a result of the burning, or oxidation, the sulphur content of the pyrite or pyritiferous ore is converted into sulphur dioxide gas. When the ore contains over 30 per cent of sulphur, the heat generated by the oxidation of the sulphur is sufficient to maintain combustion without fuel. The sulphur dioxide gas produced in this manner is purified, and subsequently converted into sulphuric acid, either by the chamber process, in which the oxidation is accomplished by nitric oxide gases and steam, or by the contact process, previously described.

TABLE 6.—DETAILED SUMMARY: 1902.

	United States.	Virginia.	All other states.[1]
Number of mines	23	6	17
Number of operators	18	4	14
Character of ownership:			
Individual	1	1	....
Firm	3	1	2
Incorporated company	14	2	12
Salaried officials, clerks, etc.:			
Total number	54	32	22
Total salaries	$49,890	$29,970	$19,920
General officers—			
Number	6	4	2
Salaries	$9,050	$7,450	$1,600
Superintendents, managers, foremen, surveyors, etc.—			
Number	31	17	14
Salaries	$28,582	$13,952	$14,630
Foremen below ground—			
Number	7	3	4
Salaries	$5,390	$3,200	$2,190
Clerks—			
Number	10	8	2
Salaries	$6,868	$5,368	$1,500
Wage-earners:			
Aggregate average number	970	655	315
Aggregate wages	$398,870	$222,986	$175,884
Above ground—			
Total average number	541	389	152
Total wages	$199,315	$122,431	$76,884
Engineers, firemen, and other mechanics—			
Average number	126	105	21
Wages	$57,957	$45,037	$12,920
Miners—			
Average number	28	....	28
Wages	$14,196	....	$14,196
Boys under 16 years—			
Average number	13	13	....
Wages	$2,017	$2,017	....
All other wage-earners—			
Average number	374	271	103
Wages	$125,145	$75,377	$49,768
Below ground—			
Total average number	429	266	163
Total wages	$199,555	$100,555	$99,000
Miners—			
Average number	273	206	67
Wages	$122,874	$78,964	$43,910
Miners' helpers—			
Average number	108	56	52
Wages	$55,766	$20,216	$35,550
All other wage-earners[2]—			
Average number	48	4	44
Wages	$20,915	$1,375	$19,540
Average number of wage-earners at specified daily rates of pay:			
Engineers—			
$1.00 to $1.24	1	1	....
$1.25 to $1.49	7	7	....
$1.50 to $1.74	7	6	1
$1.75 to $1.99	6	2	4
$2.00 to $2.24	5	4	1
$2.25 to $2.49	1	....	1
$2.50 to $2.74	2	1	1
Firemen—			
$1.00 to $1.24	6	6	....
$1.25 to $1.49	11	9	2
$1.75 to $1.99	1	1	....
$2.00 to $2.24	2	1	1
$2.25 to $2.49	2	....	2
Machinists, blacksmiths, carpenters, and other mechanics—			
$1.00 to $1.24	23	23	....
$1.25 to $1.49	23	23	....
$1.50 to $1.74	12	9	3
$1.75 to $1.99	5	4	1
$2.00 to $2.24	6	6	....
$2.50 to $2.74	5	2	3
$3.00 to $3.24	1	....	1
Miners—			
$1.00 to $1.24	33	33	....
$1.25 to $1.49	110	103	7
$1.50 to $1.74	88	60	28
$1.75 to $1.99	5	5	....
$2.00 to $2.24	43	4	39
$2.50 to $2.74	16	1	15
$3.00 to $3.24	6	....	6

	United States.	Virginia.	All other states.[1]
Average number of wage-earners at specified daily rates of pay—Continued.			
Miners' helpers—			
$1.00 to $1.24	30	30	....
$1.25 to $1.49	25	25	....
$1.50 to $1.74	6	1	5
$1.75 to $1.99	12	....	12
$2.50 to $2.74	35	....	35
Timbermen and track layers—			
$1.50 to $1.74	1	1	....
$1.75 to $1.99	16	....	16
Boys under 16 years—			
Less than $0.50	5	5	....
$0.50 to $0.74	7	7	....
$0.75 to $0.99	1	1	....
All other wage earners—			
Less than $0.50	10	10	....
$0.50 to $0.74	45	45	....
$0.75 to $0.99	49	49	....
$1.00 to $1.24	195	162	33
$1.25 to $1.49	29	4	25
$1.50 to $1.74	55	3	52
$2.00 to $2.24	11	1	10
$2.25 to $2.49	11	....	11
Average number of wage-earners employed during each month:			
Men 16 years and over—			
January	947	659	288
February	945	663	282
March	965	673	292
April	964	643	321
May	992	657	335
June	1,032	686	346
July	1,041	730	311
August	1,004	673	331
September	959	620	339
October	928	599	329
November	900	583	317
December	807	518	289
Boys under 16 years—			
January	8	8	....
February	8	8	....
March	10	10	....
April	16	16	....
May	17	17	....
June	18	18	....
July	18	18	....
August	16	16	....
September	11	11	....
October	12	12	....
November	10	10	....
December	12	12	....
Contract work:			
Amount paid	$3,587	$1,134	$2,453
Number of employees	15	4	11
Miscellaneous expenses:			
Total	$39,118	$23,285	$15,833
Royalties, and rent of mine and mining plant	$7,048	....	$7,048
Rent of offices, taxes, insurance, interest, and other sundries	$32,070	$23,285	$8,785
Cost of supplies and materials	$217,262	$137,491	$79,771
Product:			
Quantity, long tons	207,874	127,642	80,232
Value	$947,089	$501,642	$445,447
Power:			
Total horsepower	6,305	1,400	4,905
Owned—			
Engines—			
Steam—			
Number	32	22	10
Horsepower	5,915	1,160	4,755
Gas or gasoline—			
Number	1	....	1
Horsepower	20	....	20
Other power—			
Number	4	3	1
Horsepower	320	240	80
Rented—			
Horsepower	50	....	50
Electric motors, owned—			
Number	2	2	....
Horsepower	80	80	....

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[1] Includes operators distributed as follows: Alabama, 1. California, 2, Georgia, 1, Louisiana, 1; Massachusetts, 1, Missouri, 2, Nevada, 1; New York, 1; Ohio, 3 (6 mines); Utah, 1.

[2] Includes timbermen and track layers.

BARYTES

BARYTES.

By Joseph Hyde Pratt.

The mining of barytes has been carried on in the United States for about fifty years, but it is still an industry of minor importance. Barytes was first produced in small quantities for use as an adulterant of white lead. Statistics of production for 1902 are presented in Table 1, with such facts as are available for the censuses of 1860, 1870, 1880, and 1890.

Table 1.—*Production of barytes: 1860 to 1902.*

CENSUS	Quantity (short tons).	Value	Where produced
1860	...	$25,000	New York
1870	...	100,000	Connecticut
1880	3,608	37,491	Georgia, Missouri, Pennsylvania, Virginia.
1890 (for calendar year 1889).	21,460	106,313	Missouri, Virginia, Illinois
1902	61,668	203,154	Missouri, North Carolina, Tennessee, Virginia

At the census of 1860 the statistics of this mining industry were not separately reported, but were included among those for manufactures. Returns were given for 1 barytes establishment in Westchester county, N. Y., which had 40 employees, who received $12,000 in wages. The cost of materials was given as $5,000, and the value of product as $25,000.

The only statistics reported for this industry at the census of 1870 were those of 1 establishment in New Haven county, Conn., which employed 110 men, all above ground, to whom $78,000 was paid in wages. The cost of materials was $5,518, the capital $50,000, and the value of the product (quantity not stated) $100,000. The deposit, which was located at Cheshire, had been mined quite extensively, as is shown by the old workings.

At the census of 1880 the statistics for barytes were shown under minor minerals, and a total of 6 mines was reported for the states of Georgia, Missouri, Pennsylvania, and Virginia. These employed 63 wage-earners, to whom was paid $7,802 in wages. The cost of materials was given as only $200, making the total cost $8,002 for the production of 3,608 tons, which was valued at $37,491. This is an increase of $12,491 in the value of the production of 1880 over that of 1860.

At the Eleventh Census mining industries were shown separately, and included barytes. The statistics, however, for this mineral were not uniform for the whole country, and are not, therefore, comparable with those for 1902.[1]

The quantity of barytes produced in 1889 was given as 21,460 short tons, valued at $106,313, an increase of 17,852 tons in quantity, and of $68,822 in value, over that for the year 1880. Most of this production was obtained from Missouri and Virginia, with a smaller amount from Illinois.

At the census for the calendar year 1902, the quantity of barytes produced was given as 61,668 short tons, valued at $203,154, which is an increase of 40,208 short tons in quantity and of $96,841 in value, over the production reported at the census of 1890.

In 1902 no product of barytes was reported for New York, Connecticut, Georgia, and Illinois, although these states were returned as producers at one or all of the censuses of 1860, 1880, and 1890.

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[1] Barytes mining in Missouri is carried on in such a very irregular manner that it is impossible to obtain any reliable statistics relative to labor and wages. Farmers mine it in off seasons; that is, when there is no farming to do they employ themselves and their hands in getting out the barytes found on their farms, haul it to the nearest tradesman, and receive in exchange dry goods, groceries, or other necessaries, or cash. The farmers thus occupy time which would otherwise be idle, and dispose of the barytes at a less figure than it would pay to mine it systematically. The supply thus obtained is nearly sufficient to keep the mills up to their fullest capacity.

A few mines are, however, operated with some degree of system, though for want of proper records it is necessary to estimate a considerable portion of the matter of labor and wages. The mines altogether give irregular employment to about 580 men. The rate of compensation for foremen is about $2.50 per day, and for laborers from $1 to $1.50 per day. It is rarely, however, that the men make full time, and their daily earnings are reported at from 50 to 75 cents. From 75 to 100 women obtain the same sort of irregular employment, earning about 35 cents per day. Boys get from 25 to 30 cents per day. One mine was active nearly the entire year, but in most cases the number of days worked at the mines ranged from 125 to 200. One mine in Illinois employed 10 men and 2 women for 52 days. (Eleventh Census, Mineral Industries, page 745.)

The large increase in the use of white lead is one of the principal reasons for the increase in the production of barytes. This mineral was formerly considered simply as an adulterant, but it is now beginning to be recognized that it has qualities of its own that make it of value as a pigment, and when it is used in combination with white lead or zinc white, these qualities appear to advantage.

Table 2 is a summary of the statistics for 1902.

TABLE 2.—*Summary: 1902*

Number of mines or quarries	49
Number of operators	42
Salaried officials, clerks, etc.:	
Number	28
Salaries	$15,159
Wage-earners:	
Average number	336
Wages	$130,285
Contract work	$1,000
Miscellaneous expenses	$55,555
Cost of supplies and materials	$7,772
Product:[1]	
Quantity, short tons	61,668
Value	$203,154

[1] Includes 539 tons, valued at $1,618, the product of two lead mines, the wages and other details are embraced in the statistics for lead.

Of the 49 mines or quarries shown for 1902, 34 are in Missouri, 5 in North Carolina, 6 in Tennessee, and 4 in Virginia. These were controlled by 42 operators, of whom 16 were individuals, 20 firms, and 6 incorporated companies. Each of 2 firms operated 4 mines. Missouri leads in this industry, with 69.4 per cent of the mines and 51.5 per cent of the value of the production. North Carolina is next in respect to the value, with 21.7 per cent, and Virginia third, with 19.5 per cent. Tennessee produced only 7.2 per cent of the total value of the production, although reporting 6 mines, which is 1 more than North Carolina and 2 more than Virginia.

Six mines or quarries were idle during the year, 1 each in Missouri and Ohio, and 2 each in Tennessee and Virginia.

Capital stock of incorporated companies.—Table 3 shows the capitalization and bonded indebtedness of the 6 incorporated companies.

TABLE 3.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	6
Capital stock and bonds issued	$1,158,900
Capital stock (all common):	
Total authorized—	
Number of shares	115,056
Par value	$10,988,000
Total issued—	
Number of shares	15,019
Par value	$979,900
Dividends paid	$2,640
Bonds:	
Authorized—	
Number	1,700
Par value	$1,700,000
Issued—	
Number	179
Par value	$179,000
Interest paid	$8,000

Two of these companies were operating in Missouri, 2 in North Carolina, and 2 in Virginia. The entire stock, both authorized and issued, is common stock. A little more than 8.9 per cent, par value, of the authorized stock has been issued and a little more than 10.5, par value, of the bonds. Dividends of $2,640 were paid on $58,000 of the $979,900 capital stock issued.

Employees and wages. There were at the 49 mines or quarries a total average number of 364 employees, of whom 28, or 7.7 per cent, were classified as salaried employees, and 336, or 92.3 per cent, as wage-earners. Of the total amount, $145,444 reported as paid for salaries and wages by the 42 operators engaged in the production of barytes, $130,285, or 89.6 per cent, was paid to the wage-earners and $15,159, or 10.4 per cent, to the salaried employees. The classification of these 364 salaried employees and wage-earners is shown in Table 6.

Of the 321 wage-earners classified as miners or quarrymen, only 51, or 15.9 per cent, were employed below ground, of which 31 were in North Carolina, 16 in Virginia, and only 4 in Missouri, although the latter state produces over one-half of the total production. This is due to the entirely different occurrence of the deposits of barytes in North Carolina and Virginia as compared with those in Missouri. In the latter state the deposits occur near the surface, so that they can be worked almost entirely by means of pits and open cuts, while those in Virginia and North Carolina have to be worked largely by means of shafts, tunnels, and drifts. There was obtained from those mines reporting wage-earners below ground a production of barytes valued at $62,900, or 31 per cent of the total value. The total underground wage-earners numbered 52, or 15.5 per cent of the total wage-earners, and their wages constituted 12.1 per cent of the total wages paid. The 8 wage-earners shown under "all other wage-earners" are laborers who handle, load, and haul the ore and do miscellaneous work.

There were on an average 7 wage-earners to a mine or quarry. In addition to the number of regularly employed wage-earners, 10 were employed in contract work in North Carolina at an expense of $1,000. They worked altogether a total of one hundred days.

The number of wage-earners employed during each month, and their daily rates of pay, are shown in Table 6. The busiest month of the year for the industry as a whole was the month of May, when a total of 443 wage-earners were at work. August was the next busiest month, with 441. The least active month was December, with 144. Many of the companies in Missouri employ no regular miners, the work being done by the farmers of the neighborhood who work in the mines at odd times. The company pays them for the ore dug, whether it comes in small or large quantities, or whether by bucket, sack, barrel, or wagon load. Of the total number of wage-earners 321, or 95.5 per cent, are classed as miners. Of this number the wages of 135, or 42.1 per cent, ranged from $1 to $1.24 per day, and those of 66, or 20.6 per cent, ranged from $1.75 to

$1.99 per day. The miner who received from $0.50 to $0.74 a day was employed in Virginia. The prevailing wages for all classes of wage-earners was from $1 to $1.24 a day, there being 143, or 42.6 per cent, paid at this rate.

Supplies, materials, and miscellaneous expenses.—The amount expended for supplies and materials was $7,772. Of the miscellaneous expenses, amounting to $35,555, $27,300, or 76.8 per cent, was expended for royalties and rent of mines and mining plant, the remainder being for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—Of the 42 operators from whom returns were received only 2 reported that power was required for the operation of their mines. These were in North Carolina and Virginia. The total horsepower amounted to 110, furnished by 3 steam engines.

Production.—The total production of barytes for the calendar year 1902 was 61,668 short tons, valued at $203,154, of which Missouri produced 31,334 short tons, or 50.8 per cent of the total; North Carolina, 14,679 short tons, or 23.8 per cent; Tennessee, 3,255 short tons, or 5.3 per cent; and Virginia, 12,400 short tons, or 20.1 per cent. A comparison of the production for this industry since 1889 is shown in the following table, which gives the statistics relating to the quantity and value of barytes, as published by the United States Geological Survey:

TABLE 4.—*Production of barytes: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (short tons).	Value.	Average value per ton.
1889	21,460	[1] $106,313	$4.95
1890	21,911	86,505	3.95
1891	31,069	118,363	3.81
1892	32,108	130,025	4.05
1893	28,970	88,506	3.06
1894	23,335	86,983	3.73
1895	21,529	68,321	3.17
1896	17,068	46,513	2.73
1897	26,042	58,295	2.23
1898	31,306	108,339	3.50
1899	41,894	139,528	3.33
1900	67,680	188,089	2.78
1901	49,070	157,844	3.22
1902	61,668	203,154	3.29

[1] Value includes floated barytes when sold first in that form.

As shown by the above table, there was an increase of 12,598 tons in quantity and of $45,310 in value in the production of 1902 over that of 1901. Of the 1902 production 539 tons, valued at $1,618, were obtained as a by-product from 2 lead mines; and the salaries, wages, and other expenses of these mines are credited to the lead industry.

The largest production reported for this industry was in 1900, when it amounted to 67,680 short tons. In value, however, 1902 leads with a valuation of $203,154, while that of 1900 was $188,089. This is due to the higher average price received per ton for the barytes in 1902, which was $3.29, or 51 cents more than the average price of $2.78 per ton received in 1900. The total quantity of barytes produced in the United States since 1882 is 622,950 short tons, an average production of 29,664 tons per year.

The highest average value reported in the table for any year was $4.95 in 1889, and the lowest $2.23 in 1897. In 1902 the price per ton reported varied from $1.65 to $4.50, but the average was $3.29 per ton.

In 1902, there were imported barytes, manufactured and unmanufactured, to the value of $51,711, and other barium compounds, nearly all of which could be made of domestic barytes, to the value of $152,361. The imports of barytes from 1889 to 1902, inclusive, as published by the United States Geological Survey, are shown in the following table:

TABLE 5.—*Imports of barytes: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING DECEMBER 31—	MANUFACTURED.		UNMANUFACTURED.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1889	1,801	$22,458	6,785	$7,600
1890	1,583	16,463	4,815	13,133
1891	2,149	22,041	2,900	8,816
1892	1,389	16,419	2,789	7,418
1893	1,032	11,457	2,983	7,612
1894	836	10,556	1,884	5,270
1895	1,629	17,112	2,551	7,561
1896	2,467	23,345	509	1,274
1897	1,300	13,822	502	579
1898	687	8,678	1,022	2,678
1899	2,111	22,919	1,739	5,488
1900	2,454	24,160	2,568	8,301
1901	2,454	27,002	3,150	12,890
1902	3,908	37,389	3,929	14,322

Table 6 is a detailed summary of the statistics of the barytes industry for 1902.

DESCRIPTIVE.

The first mining for barytes in the United States was very probably in Westchester county, N. Y., prior to 1860, and this was followed in the next decade, 1860 to 1870, by the opening of the mine at Cheshire, New Haven county, Conn. Between 1870 and 1880 barytes deposits had been opened in Georgia, Missouri, Pennsylvania, and Virginia, while those of New York and Connecticut had ceased to be producers. Between 1880 and 1890 Illinois had been added to the states producing this mineral, and during the next decade, from 1890 to 1900, North Carolina and Tennessee became producers, and in 1902 deposits of this mineral began to be developed in Kentucky. This makes a total of 9 states in which this mineral has been found in commercial quantity. In 1902 Missouri, North Carolina, Tennessee, and Virginia were producers of this mineral, with known deposits in Illinois and Kentucky, which are being developed, with the expectation of putting their product on the market in 1903. The Missouri deposits are furnishing more than one-half of the barytes mined in the United States. They are located in Cole, Crawford, Miller, St. Francois, and Washington counties, with by far the larger proportion of the mines in the last-named county. There are a number of deposits in these five counties that probably contain barytes in quantity, but on account of their distance from the railroad they are not mined to any great extent at the present time. The mineral is found for the most part associated with limestone. This rock is often altered and decomposed to some depth, leaving a residual clay-like material in which the barytes, which has resisted the alteration, is found. Sometimes the barytes is encountered close under the grass roots. The lead ore, galena, is associated more or less with the barytes, and it makes a very valuable by-product, although occasionally a deposit is found that is practically free from this mineral. Where the barytes is encountered near the surface in the clay, it is apt to be stained more or less with iron oxide.

In North Carolina the barytes deposits occur in Gaston, Madison, and Orange counties, those which were worked most extensively during 1902 being in Madison county. The mining in this state is largely by means of shafts, tunnels, and drifts.

The Tennessee barytes deposits are located in Bradley, Cocke, Greene, Loudon, and Monroe counties, but during 1902 the production of this mineral was much less than the year before. The erection, however, of a large barytes mill for grinding this mineral and preparing it for market, and also for the production of artificial sulphate of barium, and other compounds of barium, will undoubtedly lead to a considerable increase of the industry in this state.

In Virginia the barytes mines are located in Bedford, Campbell, Louisa, Pittsylvania, Russell, and Tazewell counties. The mines near Evington, Campbell county, where the mining is now carried on largely by means of shafts and drifts, have been worked almost continuously since 1874. About 1901 the deposits of Russell and Tazewell counties were opened, and the latter gives prospect of becoming the largest producer of this mineral in Virginia.

The deposits of barytes that are being developed in Illinois are in Hardin county, and those of Kentucky are in Crittenden county.

The growth of this industry has been partially dependent on the growth of the paint industry, in which a very large proportion of the barytes produced is used. The barytes has a pure white color, which is permanent, and it is unaffected by weather or by gases that in some instances blacken white lead, for which the barytes is used as a substitute. Besides the use of barytes in the paint industry, it is employed in the manufacture of paper and rope to give weight; and also in the preparation of a material that is used to coat the canvas sacks in which hams are wrapped when ready for market. Another use for this mineral, and one that should increase rapidly, is in the manufacture of other barium compounds, principally the hydroxide. This compound was formerly prepared almost exclusively from the mineral witherite, barium carbonate; but on account of its rare occurrence in commercial quantity, barytes has begun to be the raw material used in the manufacture of this hydroxide and other salts of barium. One of the greatest uses of the barium hydroxide will perhaps be in the beet sugar industry, for the separation of the sugar left in the molasses. It is also claimed that the compound is applicable in the cane sugar industry. Other uses considered for it are in the purifying of water used in steam boilers and in the preparation of hides for tanning. As these uses of barium hydroxide increase there should be a larger demand, and consequently a larger production of barytes.

These multiplying uses for barytes put the industry on a new basis, and take the mineral out of the list of adulterants with which it has been usually classified.

Table 6.—DETAILED SUMMARY: 1902.

	United States.	Missouri.	North Carolina.	Tennessee.	Virginia.
Number of mines or quarries	49	34	5	6	1
Number of operators	42	28	5	6	3
Character of ownership:					
Individual	16	10	....	5	1
Firm	20	16	3	1	....
Incorporated company	6	2	2	....	2
Salaried officials, clerks, etc.:					
Total number	28	4	13	1	10
Total salaries	$15,159	$670	$5,401	$1,000	$8,088
General officers—					
Number	8	2	1	....	5
Salaries	$5,308	$300	$1,000	....	$4,008
Superintendents, managers, foremen, surveyors, etc.—					
Number	7	1	2	1	3
Salaries	$5,570	$70	$1,500	$1,000	$3,000
Foremen, below ground—					
Number	9	....	8	....	1
Salaries	$3,001	....	$2,401	....	$600
Clerks—					
Number	4	1	2	....	1
Salaries	$1,280	$300	$500	....	$480
Wage-earners:					
Aggregate average number	336	239	34	26	37
Aggregate wages	$130,285	$99,799	$9,914	$7,525	$13,047
Above ground—					
Total average number	284	235	2	26	21
Total wages	$114,551	$98,529	$450	$7,525	$8,047
Engineers, firemen, and other mechanics—					
Average number	4	....	2	1	1
Wages	$1,650	....	$450	$600	$600
Miners or quarrymen—					
Average number	270	235	....	23	12
Wages	$110,086	$98,529	....	$6,625	$4,932
Boys under 16 years—					
Average number	2	....	....	2	....
Wages	$300	....	....	$300	....
All other wage-earners—					
Average number	8	....	....	....	8
Wages	$2,515	....	....	....	$2,515
Below ground—					
Total average number	52	4	32	....	16
Total wages	$15,734	$1,270	$9,464	....	$5,000
Miners—					
Average number	51	4	31	....	16
Wages	$15,446	$1,270	$9,176	....	$5,000
Miners' helpers—					
Average number	1	....	1	....	....
Wages	$288	....	$288	....	....
Average number of wage-earners at specified daily rates of pay					
Engineers—					
$2.00 to $2.24	2	....	....	1	1
Firemen—					
$0.75 to $0.99	2	....	2	....	....
Average number of wage-earners at specified daily rates of pay—Cont'd.					
Miners or quarrymen—					
$0.50 to $0.74	1	....	....	....	1
$0.75 to $0.99	15	2	3	10	....
$1.00 to $1.24	135	80	28	10	17
$1.25 to $1.49	30	17	....	3	10
$1.50 to $1.74	74	74	....	....	....
$1.75 to $1.99	66	66	....	....	....
Miners' helpers—					
$0.75 to $0.99	1	....	1	....	....
Boys under 16 years—					
$0.50 to $0.74	2	....	....	2	....
All other wage earners—					
$1.00 to $1.24	8	....	....	....	8
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	244	160	44	23	17
February	402	308	42	35	17
March	414	332	42	23	17
April	418	326	44	23	25
May	443	334	43	23	43
June	426	329	31	23	43
July	427	324	27	33	43
August	437	319	27	33	58
September	306	200	27	33	46
October	194	134	27	17	16
November	153	69	27	11	46
December	144	63	27	11	43
Boys under 16 years—					
January	4	....	....	4	....
February	4	....	....	4	....
June	4	....	....	4	....
July	4	....	....	4	....
August	4	....	....	4	....
September	4	....	....	4	....
Contract work:					
Amount paid	$1,000	....	$1,000	....	....
Number of employees	10	....	10	....	....
Miscellaneous expenses:					
Total	$35,555	$18,951	$5,886	$475	$10,243
Royalties and rent of mine and mining plant	$27,300	$11,515	$5,680	$455	$9,650
Rent of offices, taxes, insurance, interest, and other sundries	$8,255	$7,436	$206	$20	$593
Cost of supplies and materials	$7,772	$2,105	$2,740	$840	$2,087
Product:					
Quantity, short tons	61,668	31,334	14,679	3,255	12,400
Value	$203,154	$104,677	$44,130	$14,647	$39,700
Power owned:					
Total horsepower	110	....	100	....	10
Engines—					
Steam—					
Number	3	....	2	....	1
Horsepower	110	....	100	....	10

MINERAL PIGMENTS, CRUDE.

MINERAL PIGMENTS, CRUDE.

By Joseph Struthers, Ph. D.

As early as 1850 the census statistics of ocher, which is a subclassification of crude mineral pigments, appeared among statistics of manufactures. There were only 2 establishments, and they were in Vermont. In 1860, 1 establishment was shown, also among manufacturing statistics, in Berkshire county, Mass. A census of mining industries was taken at the census of 1870, and ocher was included among stone quarrying industries. There were 4 establishments, all in Bennington county, Vt. Among the mining industries at the census of 1880, 7 establishments were given—1 in New Jersey and 3 each in Vermont and Virginia—but, according to a footnote, there were a few ocher mines in Virginia or West Virginia from which no returns were received.

At the Eleventh Census statistics were given among mineral industries for ocher and metallic paint. The number of establishments was not stated. The states of Alabama, Colorado, Georgia, Maryland, Massachusetts, Pennsylvania, Vermont, Virginia, and Wisconsin were shown for ocher, and Alabama, Colorado, New York, Ohio, Pennsylvania, Tennessee, and Wisconsin for metallic paints. The statistics were for the year 1889 and apparently included statistics of the manufacture of ores into marketable paints.

The substances included in this report, under the title "Mineral pigments, crude," are: Iron ores, hematite, or red iron ore (Fe_2O_3), and limonite of brown iron ore (Fe_2O_3, $3H_2O$); clay and other earths, comprising ocher (yellow, gray, and brown) umber (including Spanish brown), and sienna; soapstone, slate, and shale, utilized for making certain shades of gray pigment; and gypsum, or mineral white, used as a pigment for printing wall paper.

Table 1 presents comparative statistics for the industry for 1902, 1889, 1880, and 1870.

Table 1.—*Comparative summary: 1870 to 1902.*

	1902	1889[1]	1880[2]	1870[2]
Number of mines or quarries	35	(3)	7	(3)
Number of operators	35	(3)	(3)	4
Salaried officials, clerks, etc.:				
Number	65	8	(3)	(3)
Salaries	$85,666	$5,540	(3)	(3)
Wage-earners:				
Average number	256	387	100	12
Wages	$106,087	$129,515	$21,396	$5,600
Contract work		$8,674	(3)	(3)
Miscellaneous expenses	$21,889	$21,796	(3)	(3)
Cost of supplies and materials	$58,073	$84,509	$1,890	$1,980
Product:[4]				
Quantity, short tons	35,179	36,184	4,037	(3)
Value	$300,885	$463,766	$135,840	$15,000

[1] Ocher and metallic paint only.

[2] Ocher only.

[3] Not reported.

[4] The United States Geological Survey reports 73,049 short tons of mineral paints, manufactured and sold, valued at $941,332. Census figures are for the crude mineral pigments.

The 35 mines reported for this industry in 1902 were controlled by 22 incorporated companies, 8 individuals, and 5 firms. The state of Pennsylvania led in production, having 58.6 per cent of the total quantity and 68.3 per cent of the total value; the state of Georgia was next, with 16 per cent of the quantity and 13.4 per cent of the value; Maryland had 7.1 per cent and 3 per cent, respectively; New York reported 3.6 per cent of the quantity and 1.2 per cent of the value, leaving for all other states 14.7 per cent and 14.1 per cent, respectively.

There were 13 mines reported idle during 1902, controlled by 6 incorporated companies, 4 firms, and 3 individuals. The 6 incorporated companies issued capital stock and bonds to the par value of $86,750, the total amount authorized being $96,750. Three of the mines were in California, 2 each in Georgia and Missouri, and 1 each in Alabama, Michigan, Ohio, Pennsylvania, Tennessee, and Vermont. From these 13 mines miscellaneous expenses to the amount of $36 were reported. The total horsepower of the engines at these idle mines was given as 115 3 steam engines having a total of 95 horsepower and 1 water wheel with 20 horsepower.

Capital stock of incorporated companies.—The details of capital stock and funded debt are shown in the following table for 17 of the 22 incorporated companies controlling active mines. The figures for the remaining 5 companies are omitted because mining is but a small part of the total business of each.

TABLE 2.—*Capitalization of incorporated companies: 1902.*

	United States.	Georgia.	Pennsylvania.	All other states.
Number of incorporated companies	22	4	10	[1] 8
Number reporting capitalization	17	3	10	[2] 4
Capital stock and bonds issued	$946,700	$156,100	$650,600	$140,000
Capital stock:				
Total authorized—				
Number of shares	76,316	52,200	22,566	1,550
Par value	$1,400,300	$170,000	$1,075,300	$155,000
Total issued—				
Number of shares	67,361	51,492	14,469	1,400
Par value	$881,700	$126,100	$615,600	$140,000
Dividends paid	$11,439	....	$9,939	$1,500
Common—				
Authorized—				
Number of shares	74,916	52,200	21,166	1,550
Par value	$1,310,300	$170,000	$985,300	$155,000
Issued—				
Number of shares	66,058	51,492	13,166	1,400
Par value	$801,400	$126,100	$535,300	$140,000
Dividends paid	$10,239	....	$8,739	$1,500
Preferred—				
Authorized—				
Number of shares	1,400	....	1,400	....
Par value	$90,000	....	$90,000	....
Issued—				
Number of shares	1,303	....	1,303	....
Par value	$80,300	....	$80,300	....
Dividends paid	$1,200	....	$1,200	....
Bonds:				
Authorized—				
Number	30,100	30,000	100	....
Par value	$65,000	$30,000	$35,000	....
Issued—				
Number	30,100	30,000	100	....
Par value	$65,000	$30,000	$35,000	....
Interest paid	$2,850	$1,500	$1,350	....

[1] Includes companies distributed as follows: Arkansas, 1; California, 1; Missouri, 2; New York, 2; Virginia, 1; Wisconsin, 1.

[2] Includes companies distributed as follows: Arkansas, 1; Missouri, 2; New York, 1.

Ten of the incorporated companies were in Pennsylvania, 4 in Georgia, 2 each in Missouri and New York, 1 each in Arkansas, California, Virginia, and Wisconsin. The capital stock and funded debt of the Pennsylvania companies was 68.7 per cent of the total. The par value of the capital stock issued by all the companies was 63 per cent of the total par value authorized. The bonded indebtedness was 6.9 per cent of the capital stock and funded debt. The dividends paid amounted to 1.3 per cent of the total stock issued and 3.4 per cent of the total stock on which they were declared. Eighty-nine and five-tenths per cent of the total amount paid in dividends was declared on common stock and 10.5 per cent on preferred. Of the total dividends, 86.9 per cent was paid on the stock of the Pennsylvania mines and 13.1 per cent on the stock of the mines of "all other states."

Employees and wages.—The wage-earners were 80.3 per cent of the salaried employees and wage-earners, and their wages were 66.4 per cent of the total salaries and wages. There were 7.3 wage-earners to a mine. Of all the states, Pennsylvania had by far the largest number of wage-earners, leading with 57.8 per cent of the total number and 63.2 per cent of the total wages paid. Georgia was next with 25.4 per cent of the wage-earners and 18.4 per cent of the wages paid, the remainder being divided between Maryland, New York, and "all other states." Of the total number of wage-earners in all the mines, 20.3 per cent were underground. Pennsylvania had 78.8 per cent of these underground workers and Georgia the remainder, or 21.2 per cent.

The average number of wage-earners employed during each month and their daily rates of pay by occupations are shown in Table 3. The number varied little the year through. The busiest months were apparently September and October, and the least busy, February and March.

No particular skill or experience is required on the part of a miner in this industry, therefore the rates of pay should not be compared with those reported for miners where greater skill is necessary. The mines are worked by open pits, shafts, or tunnels, and in some cases the ore is ground, floated, dried, or otherwise prepared for market at the mines. Of the total number of wage-earners, 90, or 35.2 per cent, are classed as miners or quarrymen, and 102 as "all other wage-earners." Of the 90 miners, 24 received from $1.50 to $1.74 per day; 23 from $1.25 to $1.49; and 21 from $0.75 to $0.99. Of the "all other wage-earners" reported, 32 received from $1 to $1.24 per day and 31 from $1.50 to $1.74. These men are employed doing miscellaneous work around the quarries, sorting the ore, washing and hauling it, etc. The rate of pay of the largest number, 86, for all occupations was from $1.50 to $1.74 per day. Those receiving the highest daily rate of pay were engineers, machinists, etc.

Supplies, materials, and miscellaneous expenses.—The amount, $58,073, reported as paid for supplies and materials, is the largest expenditure for any one item excepting wages. Of the amount, $24,893, reported for miscellaneous expenses, $13,326, or 53.5 per cent, was expended for royalties and rent, and $11,567, or 46.5 per cent, for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—Of the 35 operators from whom reports were received, 21 reported the use of power, the total being 1,840 horsepower. Of this, 1,200 horsepower, or 65.2 per cent, was steam; 550, or 29.9 per cent, water wheels; 50, or 2.7 per cent, hydraulic pump; and 40, or 2.2 per cent, gas or gasoline. Of the steam, 545 horsepower, or 45.4 per cent of the total, was used in Pennsylvania; 185, or 15.4 per cent, in Georgia; and the remainder, 470, or 39.2 per cent, in Maryland, New York, and "all other states." Of the water wheels, 500 horsepower was employed in Pennsylvania and 50 in New York. "All other states" had all the gas or gasoline horsepower, and Georgia the hydraulic pump.

Production. The United States Geological Survey has published annual statistics concerning the quantity and value of mineral paints, beginning with 1894, and of some of the subclassifications from various dates, but these statistics are not comparable with those of the census, for the reason that they include the manufacture of the ore into paints and are not limited to the value of the crude ore at the mines. The Census statistics for 1902 include only that part of the manufacture which is done at the mines and which it is impossible to segregate, the mining and manufacture being in such cases accomplished with the same capital and under the same management. From the reports received for 1902, the various ores and clays from which mineral paints were made ranged in value from $1 (for red rock pigment) to $80 (for zinc white) per ton. The average value per ton was $10.17. Allowance must be made for the great variation in the average value due to the comparatively wide range in quantities and materials. The classification of crude mineral pigments includes yellow, gray, and brown ocher, umber, sienna, zinc white, white mineral (gypsum), slate (sold for pigment), carbonate of iron and of zinc, oxide of iron, and other pigments. With ocher some of the previous censuses have included a little of umber and sienna. Ochers are known as those clays to which the natural mixing of iron peroxide and water has imparted a bright red or reddish-yellow color, while the iron pigments are those from which the darker red or brown paints are made. In the statistics of production given at the census of 1902, there are by-products of 390 tons of soapstone used for pigment, valued at $2,340, and 18 tons of slate, valued at $525. The capital, wages, and other expenses attending the production are given under "Talc and soapstone" and "Slate."

A detailed summary showing the statistics for crude mineral pigments during 1902 is given in Table 3.

DESCRIPTIVE.

Pigments are substances, both natural and artificial, which are usually insoluble in water, oils, and other neutral solvents, and are used to impart color to a body either by surface adhesion or by direct admixture with its substance. Generally there is no chemical combination between the pigment and the body it covers. When mixed with a drying oil, or with water containing oil or size, the pigments form the basis of paint which is used for decorative or protective purposes.

The natural pigments, the only ones with which this report is concerned, are among the most important but are fewer in number than those prepared artificially by chemical precipitation or other processes. According to Thorp[1] the chief pigments are classified as follows: *Whites:* White lead, lead sulphate, lead oxychloride, zinc white, zinc sulphide, barytes, gypsum, and whiting. *Blues:* Ultramarine, Prussian blues, smalt, cobalt blues, copper blues, and indigo. *Violet:* Ultramarine. *Greens:* Ultramarine, Brunswick green, chrome green, Guignet's green, copper greens, and copper and arsenic greens. *Yellows:* Chrome yellow, yellow ocher, cadmium yellow, orpiment, litharge, gamboge, and Indian yellow. *Orange:* Orange mineral, chrome orange, and antimony orange. *Reds:* Red lead, chrome red, red ocher, Venetian red, vermilion, realgar, antimony red, and carmine. *Browns:* Umbers, Vandyke brown, and sepia. *Blacks:* Lampblack, ivory black, boneblack, and graphite.

Iron oxide pigments.—The iron oxide pigments are used to make dark red or brown paints, being known in the trade as "natural reds." They are classed as natural and artificial, the former (metallic paints and mortar color) being chiefly made from brown iron ore and ferruginous shales, and the latter (Venetian red, Tuscan red, and Indian red) from calcining copperas or copperas residues in a furnace yielding ferric oxide (Fe_2O_3) in a state of very fine division.

Although the occurrence of iron ores in the United States is widespread, and enormous deposits exist at many places, there are very few localities in which the material is of suitable physical and chemical composition for manufacture into metallic paint.

The ores reported for use in the manufacture of metallic paint and mineral paint were mined in Anne Arundel and Baltimore counties, Md.; Carbon county, Pa.; James county, Tenn.; Rutland county, Vt.; Bedford county, Va.; and Dodge county, Wis. The mortar colors were all reported from Northampton county, Pa. Other iron pigments reported were mined in Cattaraugus county, N. Y., and Carbon and Wyoming counties, Pa. The Venetian red reported was all mined in Anne Arundel county, Maryland.

The iron oxide paints are highly esteemed for some purposes on account of their freedom from poisonous ingredients which are found in some mineral paints, and because they resist to a marked degree the effects of light, heat, and moisture, a quality which renders them of great value for outside or exposed work. Ochers in addition resist the destructive action of salt air, and are therefore of special value in localities at or near the seacoast.

A certain proportion of metallic paint is used as a coloring matter in mortar making, and appears in some classifications under the title "mortar colors."

The mining and preparation of the crude ore for the market are very simple processes. The ore, generally obtained by open-cut or quarrying methods, is disintegrated by exposure to the atmosphere, carried to a mill, roughly crushed, dried, pulverized, and passed over a screen of bolting cloth or through some type of pneumatic separator, from which the final product is classified and packed for shipment. At times the ground ore is levigated and the settled products dried and packed for shipment.

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[1] Outlines of Industrial Chemistry, by F. H. Thorp. New York Macmillan & Co., 1898.

Ochers.—The name ocher is applied to clays and other earthy bases containing in their natural state sufficient ferrous or ferric oxide or hydroxides to impart to the mass a bright red or yellowish-red tint. The color varies from a golden yellow to a dark red, occasionally possessing various tints of blue and green.

The ochers reported were mined in Clay county, Ark.; Calaveras and Stanislaus counties, Cal.; Bartow and Richmond counties, Ga.; Berks, Lehigh, Luzerne, and Northampton counties, Pa.; Rutland county, Vt.; and Page county, Va. The sienna reported was mined in Washington county, N. Y., and the umber in Lawrence county, Pennsylvania.

The ochers have been used as paints from a very early date, the oldest applications positively recognized having been made in Italy, though it is believed that some varieties were in use still earlier by the Egyptians and Greeks. In modern times the ochers were first mined and prepared in Italy, and the siennas and umbers derive their names from the Italian towns in which they were manufactured into pigments.

Ochers are classified in many ways, according to the locality of occurrence, the composition, and the special shade of color. Practically they may be grouped into yellow, red, and brown. Yellow ocher is that which is colored by a ferric hydroxide. Red ocher owes its tint to ferric oxide, and it is therefore evident that red ocher may be prepared artificially by expelling the water from yellow ocher by calcining in a furnace or kiln. Brown ocher is red ocher modified by the presence of black manganese dioxide, which in various proportions yields a large range of brown colors, notably sienna brown, umber, Vandyke brown, and manganese brown.

The variation of ocher in shade and in quality depends chiefly, but not entirely, upon the proportion of iron oxide present as well as the quantity of water combined with the iron oxide. A red ocher, improperly called iron minium, very rich in iron oxide, is made by calcining and pulverizing limonite that is free from clay.

There are few pigments more free from adulteration than the ochers, for the reason that any filler that can be used advantageously is more costly than the ocher itself. Sometimes a little chrome yellow is added in order to improve the tone of a poor colored ocher, but the presence of this adulterant is very easily detected. Oxford ochers are the brightest and best of the mineral pigments of this class. They are obtained from Oxford, England. The German pigments are often called ochers, although improperly so, for the reason that they are ligneous earths and not ferruginous clays. The manufactured product varies greatly in quality and value, and some of the grades pass insensibly into umber or sienna.

Umber and sienna in reality are varieties of ocher which have been isolated on account of the brown color which is imparted to the natural clay material by the addition of iron and manganese oxides; raw umber is of a brown color, while burnt umber is of a somewhat richer and redder hue. Raw sienna is of a brownish yellow shade which affords a rich russet brown when burned. Intermediate shades of color are obtained by mixing natural products with various properties of iron and manganese oxides, and sometimes by mixing both raw and calcined materials together.

The mining and preparation of ochers, umbers, and siennas are similar to the practice described under iron oxide pigments, with the exception that at times the ground product, in part or wholly, is first heated in a furnace until the desired color has been obtained. In place of levigating and settling the ground material, it is sometimes passed through a pneumatic separator which yields an impalpably fine and uniform product.

Slate, shale, and soapstone.—A few tons each of slate, shale, and soapstone (the last-named being a variety of the mineral talc) are annually ground in the United States to produce a gray-colored pigment used chiefly as a filler for mineral paints, especially those of the variety called fire-retarding.

Gypsum.—Known also as terra alba and mineral white, is a natural hydrated calcium sulphate ($CaSO_4$, $2H_2O$). It is used to a minor extent as a pigment for printing wall paper. The method of making this pigment consists in grinding the mineral and treating it with acid in order to remove any tint or color resulting from the presence of iron oxide. The gypsum, or white mineral reported in 1902 was mined in Cape Girardeau county, Missouri.

Artificial pigments.—In addition to the natural iron oxide pigments, made by a simple washing and grinding of pure crude ores, there are two very important artificial iron oxide pigments made by roasting the residuum obtained from making copperas, or green vitriol ($FeSO_4.7H_2O$). One is Venetian red, composed almost wholly of artificial iron sesquioxide, and the other Indian red, which is comprised of about 40 per cent of iron sesquioxide, the balance being mainly calcium sulphate, made by adding a certain proportion of lime during or before the roasting.

There are two methods of manufacturing these artificial reds, the "dry" and the "wet." In the former method, which is the cheaper for the low grades of oxides, the impure copperas is roasted in a furnace with lime or similar material, in order to neutralize the acid in the sulphate until the desired strength and color of the product are obtained. Occasionally copperas alone is roasted until the acid constituent has been completely expelled, leaving the residuum in the form of pure iron sesquioxide; a filler (whiting or gypsum) is then added in proportions to yield the desired grade of Venetian red, some containing as little as 10 per cent of iron oxide or coloring power.

The wet method is cheaper for the manufacture of the general grades of Venetian red, but yields a less uniform product than the dry method. In principle, the waste liquor from the cleansing or pickling process in preparing iron wire or plates for galvanizing by immersion in weak sulphuric acid is treated direct by the addition of milk of lime, sodium carbonate, or similar reagents, which precipitates the iron as a hydrate or carbonate to the bottom of the tank. This precipitate is subsequently separated from the liquor by filtration through a press, the dried cakes remaining therein being subsequently roasted in furnaces, cooled, and packed for the market without grinding. The product made in this manner is not uniform in quality, and has but a limited use.

Hematite ore is sometimes ground and sold as Venetian red. The natural products, however, are inferior to the artificial and do not command as high a price.

Formerly the iron oxide pigments made in the United States did not contain more than 50 per cent of iron oxide, the higher grades being imported. Recently, however, the use of a crucible furnace of special design, which gives good control of the heat and of the oxidation, has raised the grade of the product to practically 100 per cent of iron oxide.

Improvements have also been made in the wet process, chiefly in the substitution of mechanical appliances for hand labor, which has lessened the cost of production and given a more uniform product.

Other mineral pigments.—Among other minerals used in part in the manufacture of paints are barytes, asbestos, graphite, and asphaltum.

The mineral is generally prepared as follows: The crude ore is hand sorted and the limestone rock and other foreign materials removed; the selected ore is then crushed and boiled in dilute sulphuric acid in order to remove any remaining impurities, chiefly iron oxide, which may impart a tint or color to the product. The material is then thoroughly washed after boiling to free it from acid or soluble salts and is finely ground and put on the market in four varieties: No. 1, No. 2, No. 3, and "floated" or water sorted.

Barium sulphate, known as "blanc fixe," which has been precipitated artificially as a by-product in some chemical industries, is used to a considerable extent as a filler and pigment. It has more body and greater capacity and covering power than the native mineral barite, for the reason that it is amorphous while barite is crystalline.

The chief use of barite is as a pigment which is usually mixed with white lead. In the United States it is regarded as an adulterant which depreciates the value of the paint, but in Europe it is considered a valuable addition, and in many cases a pigment composed of a mixture of barite and white lead is considered more serviceable than white lead alone, for the reason that, owing to the insolubility of barite in acids, it imparts elasticity to the mixture, gives a greater body to the paint, and resists the influence of the weather better than white lead alone.

A considerable quantity of barite is used in the form of lithophone, which is an artificial compound of barium sulphate, zinc oxide, and zinc sulphide, obtained by precipitating zinc sulphide and barium sulphate by a mixture of solutions of zinc sulphate and barium sulphide, the precipitate being washed, dried, and calcined. A type composition is given as: Barium sulphate, 68 per cent; zinc oxide, 7.2 per cent; and zinc sulphide, 24.8 per cent. The composition, however, varies with the different makes.

Asbestos can hardly be classed as a pigment, although when used as a filler its white color lightens the color of the material to which it is added. The chief use of asbestos in paint manufacture is to yield a so-called noninflammable or fireproof paint. The fibrous varieties of talc are also used for this purpose. Only a small proportion of the total production of asbestos in the United States is utilized in paint manufacture.

Both the natural mineral and the artificial product made in the electric furnace are used as a black pigment and in pencils, crayons, and in stove polish. The color of the pigment is a dull black and permanent, and on account of its resistance to the action of the atmosphere, as well as that of ordinary chemicals, it is of great value as the basis of a protective paint for coating oxidizable metals, chiefly iron and steel.

The purer grades of asphaltum are largely used as a basis for the manufacture of a black varnish, and as a protective paint for the interior of chlorine stills, bleaching powder chambers, acid tanks, and like apparatus. Asphaltum is not acted upon by ordinary chemicals, and for this reason it is invaluable for protecting structures of iron, steel, and even wood, which would be rapidly destroyed by acid fumes unless coated with some inert material.

Whiting, or Paris white, is composed of calcium carbonate ($CaCO_3$). Calcium carbonate occurs quite extensively in nature, either in the crystalline form, as the well-known mineral calcite, or calc-spar, or in the compact form, such as marble and limestone, or as the soft compact variety known as chalk. It is produced artificially as a by-product of many chemical operations. The whiting used in commerce is generally prepared by grinding and levigating pure chalk, large deposits of which occur, notably in England and France. The chief use of whiting as a pigment is to modify the shade of other pigments. It is also largely used as a basis for whitewash, and when mixed with from 15 to 18 per cent of linseed oil it forms putty.

TABLE 3.—DETAILED SUMMARY: 1902.

	United States.	Georgia.	Maryland.	New York.	Pennsylvania.	All other states.[1]
Number of mines or quarries	35	4	4	5	12	10
Number of operators	35	4	4	5	12	10
Character of ownership:						
Individual	8	......	2	2	1	3
Firm	5	......	2	1	1	1
Incorporated company	22	4	......	2	10	6
Salaried officials, clerks, etc.:						
Total number	63	8	......	......	40	15
Total salaries	$53,593	$5,134	......	......	$41,002	$7,457
General officers—						
Number	17	3	......	......	8	6
Salaries	$26,000	$1,200	......	......	$20,300	$4,500
Superintendents, managers, foremen, surveyors, etc.—						
Number	31	4	......	......	20	7
Salaries	$19,635	$3,646	......	......	$14,032	$1,957
Foremen, below ground—						
Number	3	......	......	......	3	......
Salaries	$2,250	......	......	......	$2,250	......
Clerks—						
Number	12	1	......	......	9	2
Salaries	$5,708	$288	......	......	$4,420	$1,000
Wage-earners:						
Aggregate average number	256	65	4	4	148	35
Aggregate wages	$106,087	$19,471	$1,716	$2,257	$67,006	$15,637
Above ground—						
Total average number	204	54	4	4	107	35
Total wages	$84,856	$15,693	$1,716	$2,257	$49,553	$15,637
Engineers, firemen, and other mechanics—						
Average number	33	7	1	......	18	7
Wages	$19,019	$2,996	$300	......	$12,219	$3,514
Miners or quarrymen—						
Average number	66	21	2	3	29	11
Wages	$24,590	$5,388	$816	$1,799	$12,035	$4,552
All other wage-earners—						
Average number	105	26	1	1	60	17
Wages	$41,247	$7,309	$600	$468	$25,299	$7,571
Below ground—						
Total average number	52	11	......	......	41	......
Total wages	$21,231	$3,778	......	......	$17,453	......
Miners—						
Average number	24	6	......	......	18	......
Wages	$9,904	$2,254	......	......	$7,650	......
Miners' helpers—						
Average number	19	3	......	......	16	......
Wages	$7,728	$900	......	......	$6,828	......
All other wage-earners—						
Average number	9	2	......	......	7	......
Wages	$3,599	$624	......	......	$2,975	......
Average number of wage-earners at specified daily rates of pay:						
Engineers—						
$1.00 to $1.24	3	2	......	......	1	......
$1.25 to $1.49	1	......	......	......	1	......
$1.50 to $1.74	6	......	......	......	3	3
$1.75 to $1.99	1	......	......	......	......	1
$2.00 to $2.24	4	1	1	......	2	......
$2.50 to $2.74	1	......	......	......	......	1
$3.00 to $3.24	1	......	......	......	......	1
Firemen—						
$1.00 to $1.24	1	1	......	......	......	......
$1.25 to $1.49	1	......	......	......	......	1
$1.50 to $1.74	1	......	......	......	1	......
$2.00 to $2.24	1	1	......	......	......	......
Machinists, blacksmiths, carpenters, and other mechanics—						
$1.00 to $1.24	1	1	......	......	......	......
$1.50 to $1.74	1	......	......	......	1	......
$2.00 to $2.24	1	1	......	......	......	......
$2.50 to $2.74	3	......	......	......	3	......
$3.00 to $3.24	6	......	......	......	6	......
Miners or quarrymen—						
$0.75 to $0.99	21	21	......	......	......	......
$1.00 to $1.24	14	6	......	......	8	......
$1.25 to $1.49	23	......	2	......	17	4
$1.50 to $1.74	24	......	......	1	17	6
$1.75 to $1.99	3	......	......	......	2	1
$2.00 to $2.24	4	......	......	1	3	......
$2.50 to $2.74	1	......	......	1	......	......
Miners' helpers—						
$1.00 to $1.24	3	3	......	......	......	......
$1.50 to $1.74	11	......	......	......	11	......
$1.75 to $1.99	5	......	......	......	5	......
Timbermen and track layers—						
$1.50 to $1.74	12	......	......	......	12	......
All other wage-earners—						
$0.75 to $0.99	16	15	......	......	......	1
$1.00 to $1.24	32	13	......	......	19	......
$1.25 to $1.49	13	......	......	......	10	3
$1.50 to $1.74	31	......	......	1	20	10
$1.75 to $1.99	6	......	......	......	5	1
$2.00 to $2.24	3	......	1	......	......	2
$2.50 to $2.74	1	......	......	......	1	......
Average number of wage-earners employed during each month:						
Men 16 years and over—						
January	239	57	6	1	139	36
February	236	57	6	1	136	36
March	232	57	6	1	132	36
April	237	54	2	4	139	38
May	254	60	2	8	143	41
June	263	70	2	8	139	44
July	268	73	6	8	145	36
August	264	71	6	7	144	36
September	288	68	6	6	172	36
October	280	75	2	4	168	31
November	259	74	2	......	158	25
December	252	64	2	......	161	25

[1] Includes operators distributed as follows: Arkansas, 1; California, 2; Missouri, 2; Tennessee, 1; Vermont, 1; Virginia, 2; Wisconsin, 1.

Table 3.—DETAILED SUMMARY: 1902—Continued.

	United States.	Georgia.	Maryland.	New York.	Pennsylvania.	All other states.
Miscellaneous expenses:						
Total	$24,893	$1,713	$640	$90	$21,259	$1,191
Royalties and rent of mine and mining plant	$13,326	....	$600	$25	$12,651	$50
Rent of offices, taxes, insurance, interest and other sundries	$11,567	$1,713	$40	$65	$8,608	$1,141
Cost of supplies and materials	$58,073	$13,146	$1,250	$735	$22,816	$20,126
Product:						
Quantity, short tons	35,479	5,488	2,720	1,261	20,807	5,203
Value	$360,895	$48,423	$10,960	$4,251	$246,346	$50,915
Power owned:						
Total horsepower	1,840	235	50	75	1,045	435
Engines—						
Steam—						
Number	27	6	1	1	13	6
Horsepower	1,200	185	50	25	545	395
Gas or gasoline—						
Number	2					2
Horsepower	40				....	40
Water wheels:						
Number	9		......	3	6	
Horsepower	550		......	50	500	
Other power:						
Number	1	1				
Horsepower	50	50			....	

STEEL HARDENING METALS

STEEL HARDENING METALS.

By Joseph Hyde Pratt.

Under the head of steel hardening metals are included those metals used or experimented with in the hardening of steel, although some of them are used more generally for other purposes in the form of compounds. The metals belonging to this class are nickel, chromium, tungsten, molybdenum, titanium, uranium, and vanadium. The statistics in this report relate to the production of the ore from which these metals are obtained, except that the figures for nickel and cobalt are for the matte made at the mines. In the mineral classifications, chromium appears as chrome ore, nickel as nickel and cobalt, and titanium as rutile. Manganese naturally comes under the head of steel hardening metals; but, on account of its comparatively large production, it is treated separately. Nickel and chromium have been presented separately at former censuses, but the statistics of the remaining metals have not been previously shown.

The statistics collected at the census of 1902 for the steel hardening metals are summarized in Table 1.

Table 1.—*Summary, 1902.*

	Total.	Tungsten.	Uranium and vanadium.	All other steel hardening metals.[1]
Number of mines	12	4	3	5
Number of operators	12	4	3	5
Salaried officials, clerks, etc.:				
Number	3	......	2	1
Salaries	$5,740	......	$5,500	$240
Wage-earners:				
Average number	26	2	19	5
Total wages	$20,911	$1,260	$17,040	$2,611
Contract work	$825	......	......	$825
Miscellaneous expenses	$748	$120	$500	$128
Cost of supplies and materials	$9,552	$210	$8,850	$492
Product:[2]				
Quantity, short tons	4,444	184	3,809	451
Value	$83,717	$5,975	$48,125	$29,617

[1] Includes operators as follows: Chrome ore, 1; molybdenum, 1; nickel and cobalt, 2; and rutile, 1.

[2] The United States Geological Survey does not report the value of tungsten and molybdenum, nor does it under this classification present the other metals. The report for nickel is for the refined; for cobalt, the oxide prepared from the ore, while Census figures are for the nickel and cobalt matte at the mine.

Besides the mines reporting a production during 1902, 7 were idle. These have been worked to some extent during the past few years, some of them becoming producers, while at others the work has been that of development to prove the existence of ore in quantity. The uncertainty of the demand for most of the ores has been the principal cause of their nonproduction. These idle mines were distributed, by states, as follows: Arizona, 1; California, 1; Colorado, 3; Nevada, 1; and Wisconsin, 1. They were owned by 5 individuals and 2 incorporated companies.

The total number of mines operated in 1902 was 12, distributed among 7 states, as follows: California, 1; Colorado, 6; Connecticut, 1; Missouri, 1; Oregon, 1; Virginia, 1; and Washington, 1. Of these 12 mines, 4—3 in Colorado and 1 in Connecticut—produced tungsten, and 3—all in Colorado—produced uranium and vanadium. Where there are less than 3 operators mining any one ore they are included in "all others." Of the 12 operators engaged in the production of these metals, 8 were individuals, 1 a firm, and 3 incorporated companies.

The total value of the outstanding capital stock of two of the incorporated companies was $200,000, with no bonded indebtedness. The entire authorized stock, all of which is common, has been issued, the shares numbering 1,001,000.

Of the three incorporated companies, one which produced nickel and cobalt, is not included in this table, for the reason that lead was its principal product, nickel and cobalt being merely by-products, and accordingly all statistics for this company, with the exception of the quantity and value of the nickel and cobalt produced by it, are included in the report on lead.

Production.—The total production of these various ores reported in 1902 was 4,444 short tons, valued at $83,717. Of this production 85.7 per cent of the quantity and 57.5 per cent of the value consisted of uranium and vanadium, the remainder being about 1 part tungsten and 3 parts "all others." In quantity the production of chrome ore was second, or next to uranium and vanadium, but in value was fifth. Tungsten ranked third in quantity and fourth in value; rutile, fourth in quantity and sixth, or lowest, in value; nickel and cobalt, fifth in quantity and third in value; while molybdenum, ranking lowest in quantity, was second in value.

The nickel and cobalt ores were concentrated into a matte which was valued at $352 per ton, of which value about five-sevenths was due to the cobalt contents and two-sevenths to the nickel.

The average value per ton received for the chrome ore in 1902 was $14.50. A standard chrome ore contains 50 per cent of chromic oxide (Cr_2O_3), but for every unit above this there is an increase in value of from 75 cents to $1 per ton; while, on the other hand, there is a much greater deduction for every unit below 50 per cent. For some uses, as in the lining of furnaces, chrome ores as low as 40 per cent of chromic oxide can be used.

The reported value of crude tungsten ores varied from $4.68 to $45 per ton. Before this ore is put on the market it is more or less concentrated. An ore containing from 60 to 70 per cent of tungstic oxide will bring in the general market, from $102 to $200 per ton.

Molybdenum ores have been valued at from $100 to $1,500 per ton, but the actual market value for these ores, when they are in constant demand for manufacturing purposes, will be nearer $100 per ton for a 50 to 55 per cent ore free from copper.

The value of uranium and vanadium ores is about $12.63 per ton for crude ore, which averages from 5 to 9 per cent of the oxides. When concentrated, these ores will bring as high as $320 per ton, the prices varying with the percentage of uranium and vanadium oxides.

The titanium reported at the census of 1902, which was all in the form of rutile, was valued at $12.50 per ton, this representing a crude product which had not in any way been concentrated or selected.

Table 2 shows the production of nickel and cobalt oxide in the United States from domestic ores from 1889 to 1902; also imports and exports of nickel oxide and matte. Most of the imports are from Canada, in the form of matte, the refining being done in this country. The exports are largely to the United Kingdom.

TABLE 2.—PRODUCTION OF NICKEL AND COBALT OXIDE FROM DOMESTIC ORES, AND IMPORTS ENTERED FOR CONSUMPTION: 1889 TO 1902; ALSO EXPORTS: 1894 TO 1902.

[Compiled from tables of United States Geological Survey, "Mineral Resources of the United States, 1902."]

YEAR ENDING DECEMBER 31—	PRODUCTION FROM DOMESTIC ORES			IMPORTS ENTERED FOR CONSUMPTION					EXPORTS NICKEL OXIDE AND MATTE	
	Nickel.		Cobalt oxide.	Total value.	Nickel, nickel ore, nickel oxide, alloy of nickel with copper, and nickel matte.		Cobalt oxide.			
	Quantity (pounds).	Value.	Quantity (pounds).		Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1889	¹252,663	$151,598	13,955	$238,663	97,288	$156,331	41,175	$82,332		
1890	223,488	134,093	6,788	439,481	813,870	376,279	33,338	63,202		
1891	118,498	71,099	7,200	364,351	10,600,655	321,163	23,643	43,188		
1892	92,252	50,739	7,869	488,129	4,187,890	428,062	72,827	60,067		
1893	49,399	22,197	8,422	429,434	12,427,986	386,740	28,884	42,694		
1894	9,616	3,269	6,763	340,448	9,286,733	310,581	21,038	29,867	²1,235,588	$247,568
1895	10,302	3,091	14,458	693,740	20,355,749	629,910	36,155	63,830	1,061,285	229,897
1896	17,170	4,464	10,700	666,647	23,718,411	620,425	37,180	46,222	2,756,094	600,855
1897	23,707	7,823	19,520	816,256	27,821,232	784,483	24,771	31,773	1,255,768	297,294
1898	11,145	8,366	6,247	1,583,507	60,060,240	1,534,262	33,731	49,245	5,607,620	1,290,069
1899	22,541	8,766	10,290	1,285,100	44,170,841	1,216,253	46,791	68,847	5,001,177	1,251,454
1900	9,715	5,886	6,471	1,272,535	37,300,800	1,183,884	56,073	88,651	5,820,706	1,382,727
1901	6,700	3,551	13,360	1,983,828	117,954,337	1,849,620	71,969	134,208	5,869,906	1,521,291
1902	5,748	2,701	3,730	1,588,764	33,912,750	1,437,649	79,983	151,115	3,728,607	924,579

¹Includes 35,800 pounds of nickel from Canadian mattes.

²Last six months; not separately classified prior to July 1, 1894.

The production of metallic nickel, from 1889 to 1902, in the principal producing countries of the world is given in Table 3. The French manufacturers obtained the ore from New Caledonia, Oceania, and the German from New Caledonia and Norway.

TABLE 3.—*Production of nickel in Canada, France, and Germany: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	CANADA		FRANCE		GERMANY	
	Quantity (pounds).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
1889	830,477	$498,286	330	$324,000	282	$279,630
1890	1,435,742	933,232	330	317,300	451	194,150
1891	4,626,627	2,775,976	330	319,200	504	641,480
1892	2,413,717	1,399,956	1,244	1,174,580	717	698,620
1893	3,982,982	2,070,852	2,046	1,175,720	893	774,630
1894	4,907,430	2,061,120	1,546	1,173,720	722	449,450
1895	3,888,525	1,360,984	1,545	1,034,220	698	375,800
1896	3,397,113	1,188,990	1,545	875,330	822	666,400
1897	3,997,746	1,399,137	1,245	704,425	898	710,980
1898	5,517,690	1,820,838	1,540	887,800	1,108	670,482
1899	5,744,000	2,067,840	1,740	1,004,600	1,115	660,517
1900	7,080,000	3,327,707	1,700	1,020,000	1,474	936,884
1901	8,882,000	4,707,160	1,800	1,440,000	1,639	1,190,363
1902	10,693,410	5,025,903				

Small quantities of tungsten ore (wolframite) and of tungsten iron, valued at $7,046, were imported during 1902.

The uranium and vanadium ores are mostly exported. Salts of the metals to the value of about $15,000 have been annually imported. The value of these imports for 1902 was $12,491.

Employees and wages.—The aggregate number of all classes of employees and wage-earners, as given in Table 5, was 29, who received $24,651 in salaries and wages. Of these, 3 were classified as salaried employees, receiving $3,740 in salaries; and 26 as wage-earners who were paid $20,911 in wages. Included with the 3 salaried employees was 1 foreman, employed underground, who received $1,500 salary. Of the 26 wage-earners, 15 were employed underground, all of whom were classified as miners. To this number of underground workers should be added the foreman classified as a salaried employee, which would make the total number of underground employees 16.

The wages received by these 26 wage-earners varied from 75 cents to $3.24 per day; 17, or 65.4 per cent of the total number, received from $3 to $3.24 per day. That relatively high wages were paid to these wage-earners is due to the fact that most of the mining of steel hardening metals was in the Western states. The month in which the largest number of wage-earners was employed was July, when the number reached 42. The minimum was in January, when only 15 were employed.

The production of chrome ore in the United States and the imports of chrome ore, chromate, etc., from 1889 to 1902, inclusive, are given in the following table:

TABLE 4.—PRODUCTION OF CHROME ORE IN THE UNITED STATES, AND IMPORTS OF CHROME ORE, CHROMATE, ETC.: 1889 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING DECEMBER 31—	PRODUCTION.		IMPORTS.						
	Quantity (tons).	Value	Chrome ore.		Chromate and bichromate of potash.		Chromic acid.		Total value.
			Quantity (tons).	Value.	Quantity (pounds).	Value	Quantity (pounds).	Value.	
1889	2,000	$30,000	5,474	$50,792	1,580,385	$137,253	......	$2,974	$191,019
1890	3,599	53,985	4,353	57,111	1,391,185	113,613	......	634	171,358
1891	1,372	20,580	4,459	105,764	735,254	55,897	631	203	161,864
1892	1,500	25,000	3,980	78,579	496,972	41,055	772	201	119,835
1893	1,450	21,750	6,354	58,629	976,706	78,961	3,708	641	138,231
1894	3,680	53,231	3,470	38,364	1,483,762	125,796	5,680	837	164,997
1895	1,740	16,795	5,230	82,845	2,045,910	181,242	2,083	414	264,501
1896	786	6,667	8,609	187,400	952,794	80,538	2,429	387	268,325
1897	......	......	11,570	187,439	1,329,473	108,497	71,220	5,457	301,393
1898	......	......	16,304	272,234	1,160,710	86,134	5,329	1,758	360,126
1899	......	......	15,793	284,825	1,130,965	73,610	33,134	6,360	364,795
1900	140	1,400	17,542	305,001	111,761	7,758	35,452	7,232	319,991
1901	368	5,790	20,112	363,108	430,998	29,224	53,462	10,861	403,193
1902	315	4,567	39,570	582,597	......	......	90,817	11,115	593,712

The total amount paid for supplies and various other expenses was $5,212. Of this amount $3,652 was for supplies and materials, and $735 for rent of offices, taxes, etc. The balance of $825 was paid for contract work.

The total amount of mechanical power used in the production of the ores of these steel hardening metals was 310 horsepower, 250 of which was furnished by 6 steam engines and 60 by water wheels. All the water-power was rented.

A detailed summary showing the statistics of the production of steel hardening metals during 1902 is given in Table 5.

DESCRIPTIVE.

CHROME ORE.

Chrome ore, or chromite, which contains the metal chromium, was the first of the minerals containing any of these steel hardening metals to be mined in the United States for commercial purposes. The discovery of chrome ore in this country was made about 1820[1] by Isaac Tyson, jr., at Bare Hills, Md., 7 miles north of Baltimore, but the deposit, being scanty and poor, was soon abandoned. He afterwards found the mineral at Soldiers Delight, about 15 miles northwest of Baltimore. In 1827 his attention was attracted by the appearance in the market place of Baltimore of a man from back in the country who had in his wagon several lumps of a heavy black mineral which he was using to keep a barrel from rolling about in his cart.[2] Upon testing these lumps, Mr. Tyson found the mineral to be chromite and learned that it was from Harford county, about 27 miles from Baltimore. This was the beginning of chrome mining in this country and of the chrome industry of the Tysons, which was later supplemented by manufacturing processes and has continued down to the present time. In the next year, 1828, chromite was discovered in Lancaster county, Pa., and the control of this property was also obtained by Mr. Tyson. It was afterwards developed into the famous Wood mine, which has produced about 95,000 tons of chromite. Chromite mining in Maryland and Pennsylvania continued for a great many years until many of the deposits or pockets of chromite were worked out. About the time the ore began to grow scarce in these states, it was discovered in California, and for a few years a number of thousands of tons were shipped to Baltimore. When, however, the importation of chrome ore began, about 1884, the chrome mining industry in the United States began to decline. There are known deposits of this mineral in quantity in California and North Carolina, and probably deposits exist in Pennsylvania and Maryland; but, on account of the low price at which the foreign ore can be landed at Baltimore, but a small portion of that used in the United States is mined here. New uses for chromium and the construction of railroads through some of the chrome fields will undoubtedly cause an increase in this industry during the next few years.

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[1] The Mineral Industry, Vol. II, page 151.

[2] Transactions of the American Institute of Mining Engineers, Vol. XXV, page 487.

The uses of chromite, at present the only source of chromium, can be readily divided into three heads:

1. As a mineral: In the manufacture of bricks as hearth linings for basic, open-hearth furnaces, and for water-jacket furnaces in copper smelting. For these purposes ores carrying as low as 40 per cent of chromic oxide can be used. It is also probable that chromite can be used to advantage in other furnaces, especially where it is desirable to use fluorspar as a flux.

2. In chromium alloys: Chromite is used to a considerable extent in the preparation of a ferro-chromium alloy. The preparation of this alloy, which is used in the manufacture of armor plates and armor-plate-piercing projectiles, has become a very important industry. The ferro-nickel alloy is also used in the manufacture of armor plate. It is generally made by the addition of these two alloys of iron to molten steel before it is cast into the ingot; they produce a more or less homogeneous triple alloy.

3. In chromium salts: The first use of chromite was in the preparation of the salts, chromate and bichromate of potash, used in dyeing, tanning, and in the manufacture of pigments; this continues to be its chief use. It was about 1800 that the value of these salts as pigments was discovered, but it was not until the discovery of deposits of chromite that they were used commercially. Some chromium salts are also used for medicinal purposes.

NICKEL AND COBALT.

Nickel and cobalt mining in the United States began probably in 1863 with the opening of the Gap mine, in Lancaster county, Pa. This mine was worked almost continuously and very extensively from 1863 until 1880, and was the only nickel mine then worked on the American continent. With the discovery, however, of the nickel deposits in the Sudbury district, Ontario, Canada, and the moderate prices which prevailed for nickel, work at this Gap mine began to decrease, and about 1891 ceased altogether. It is very probable that there are still good deposits of nickel ore in quantity in this mine and that in the near future it will again become a producer. Since 1891 most of the nickel and cobalt produced in the United States has been at Mine Lamotte, Mo., where it has been obtained as a by-product in lead mining. Attempts were made to mine nickel in North Carolina about 1890, and although the mineral genthite, a nickel silicate, was found in some quantity at a number of places, there was only one place—near Webster, Jackson county—that gave any indication whatever of containing it in commercial quantity. Considerable work was done, but in 1891 the mine was closed and remained so until 1902, when the shafts and drifts were reopened and several carloads of ore were shipped for experimental purposes. There has also been some development of nickel deposits in Oregon and Idaho, and a few tons of ore have been shipped for experimental purposes, but none of the mines can be called producers.

The first general use of nickel commercially was probably in the manufacture of German silver or albata, an alloy of zinc, copper, and nickel. Articles made of iron and plated with nickel have to some extent replaced those made of German silver. Another of the earlier uses of nickel was for coinage, which is yet carried on quite extensively by the United States and many of the European countries. With the introduction of nickel in the manufacture of a special steel the demand for it has largely increased, so that this use of the metal has become the most important. Large quantities of nickel steel are used in the manufacture of armor plates, turrets, propeller shafts, crank shafts, etc. Another use that has received favorable consideration is in the manufacture of nickel-steel rails, which were first used by the Pennsylvania Railroad Company, and evidently gave entire satisfaction.

Cobalt is put on the market as the oxide and used almost entirely for coloring glass, porcelain, and similar substances.

TUNGSTEN AND MOLYBDENUM.

The mining of tungsten and molybdenum ores in the United States has become an established industry within the past few years only. Tungsten ores were mined in Colorado and Connecticut, and molybdenum ores in Washington.

Until lately the uses of these metals were few, requiring a comparatively small amount of their salts to satisfy the demand. The salts of tungsten were used as a mordant in dyeing and printing and as fireproof material for wearing apparel, while the principal use of molybdenum was in the manufacture of ammonium molybdate, used by chemists in the determination of phosphoric acid. A small amount of molybdenum salts is used in the preparation of blue carmine or molybdenum blue in the coloring of porcelain. The use, however, of these two metals in the preparation of ferro alloys has led to an increased demand, especially for tungsten, which, when added to steel, increases its hardness and toughness, and is believed by some to make it superior for certain purposes to any other manufactured. Tungsten steel is also used in the manufacture of tool steel, spring steel, and sounding plates and wires for pianos, where hardness and strength are especially desired. Molybdenum steel, the beneficial properties of which are similar to those of tungsten, is beginning to be used, but in much smaller quantity.

RUTILE.

The only titanium mineral mined for commercial purposes is rutile, a titanium oxide. Titanium was formerly considered one of the very rare metals, but it has now been proved to be one of the commoner elements and is very widely distributed. In the future, besides rutile, the chief commercial source of titanium will be the mineral menaccanite (ilmenite), a titanium iron oxide. Rutile has been produced at Roseland, Nelson county, Va., and in Chester county, Pa. Only a small quantity is required to satisfy the demand, and the product does not amount to much over 100 tons of the crude ore per year.

The uses of rutile are principally in the ceramic industry for coloring porcelain and in the manufacture of artificial teeth. The titanium oxide will, under favorable conditions, impart a fine yellow color to the porcelain, and it is also capable of being used with other substances to produce secondary colors. The amount of titanium oxide used in the manufacture of artificial teeth is from five-tenths of 1 per cent to 2 per cent of the total materials used in making them.

At the present time no titanium is used commercially, as far as known, in the manufacture of titanium steel, although irons have been made containing a considerable percentage of titanium, the result of using ores for their iron contents rather than their titanium. Considerable work has been done, however, experimentally in regard to the use and value of titanium steel and with a great deal of success. It is probable that the introduction of this kind of steel into the general market is not far distant. Its properties of special interest are elasticity, and greater elongation and ductility than ordinary carbon steel.

URANIUM AND VANADIUM.

The production of uranium and vanadium ores during 1902 was all in Colorado. They have been mined in small quantities for a great many years, some of the salts of uranium being used to produce a pure black glaze on porcelain, while other salts are used in the decoration of glass and china ware, giving permanent colors. Vanadium salts are used in the coloring of glass, but principally in the preparation of vanadic acid, as a mordant, for aniline black in dyeing. The use of uranium and vanadium in the manufacture of special steels is still in the experimental stage, but enough has been done to prove that they increase tensile strength.

Table 5.—*Detailed summary: 1902.*

	Total	Tungsten	Uranium and vanadium.	All other steel hardening metals[1]
Number of mines	12	4	3	5
Number of operators	12	4	3	5
Character of ownership:				
Individual	8	4	3	1
Firm	1	....	....	1
Incorporated company	3	....	....	3
Salaried officials, clerks, etc.				
Total number	3	....	2	1
Total salaries	$3,740	....	$3,500	$240
Superintendents, managers, foremen, surveyors, etc.				
Number	2	....	1	1
Salaries	$2,240	....	$2,000	$240
Foremen, below ground—				
Number	1	....	1	....
Salaries	$1,500	....	$1,500	....
Wage earners				
Aggregate average number	26	2	19	5
Aggregate wages	$20,911	$1,260	$17,040	$2,611
Above ground—				
Total average number	11	1	5	5
Total wages	$6,727	$540	$3,576	$2,611
Engineers, firemen, and other mechanics—				
Average number	2	....	2	....
Wages	$1,200	....	$1,200	....
Miners—				
Average number	9	1	3	5
Wages	$5,527	$540	$2,376	$2,611
Below ground—				
Miners—				
Average number	15	1	14	....
Wages	$14,184	$720	$13,464	....
Average number of wage-earners at specified daily rates of pay				
Machinists, blacksmiths, carpenters, and other mechanics—				
$2.00 to $2.24	2	....	2	....
Miners—				
$0.75 to $0.99	1	....	....	1
$1.75 to $1.99	4	1	....	3
$2.50 to $2.74	2	1	....	1
$3.00 to $3.24	17	....	17	....
Average number of wage earners employed during each month.				
Men 16 years and over—				
January	15	3	9	3
February	17	3	11	3
March	23	3	17	3
April	25	3	19	3
May	25	....	22	3
June	36	3	27	6
July	42	9	27	6
August	33	....	27	6
September	33	....	27	6
October	22	....	19	3
November	21	....	12	9
December	20	....	11	9
Contract work				
Amount paid	$825	....	....	$825
Number of employees	7	....	....	7
Miscellaneous expenses, total	$735	$120	$490	$125
Rent of offices, taxes, insurance, interest, and other sundries	$735	$120	$490	$125
Cost of supplies and materials	$3,652	$210	$3,010	$432
Product				
Quantity, short tons	4,444	184	3,810	450
Value	$82,717	$5,975	$48,125	$28,617
Power.				
Total horsepower	310	280	....	30
Owned—				
Engines—				
Steam—				
Number	6	4	....	2
Horsepower	250	220	....	30
Rented—				
Horsepower	60	60	....	....

[1] Includes operators distributed as follows: Chrome ore, 1; molybdenum, 1; nickel and cobalt, 2; and rutile, 1.

ASBESTOS

ASBESTOS.

By Joseph Hyde Pratt.

Two distinct minerals are included in these statistics as asbestos, one being a variety of amphibole and the other the fibrous variety of serpentine known as chrysotile. It is the latter that is the more valuable and for which there is the greater demand. In the United States, however, it is, thus far, principally the amphibole variety that has been mined. The low value of this mineral and the uncertain demand have caused a wide variation in production. The first census statistics for asbestos were reported in 1880, when, among minor minerals in the Report on Mining Industries, 7 mines were shown to have been operated—4 in Maryland and 1 each in Georgia, New York, and South Carolina. The number of employees reported was 17, who received $1,400 in wages. There was no cost of supplies or materials given. The production of asbestos was 150 tons, valued at $4,312. The company operating in Georgia was incorporated with a capital of $10,000.

At the Eleventh Census there was no record of the number of mines or establishments. The capital represented was stated to be $42,600; the employees, including foremen and office force, were 12; and the wages paid, not including office force, but including $1,900 for development work in Wyoming, were $2,700. The cost of supplies was $525. The production for that year (which was entirely from California) was only 30 tons, valued at $1,800.

Because of the lack of uniformity of the statistics of these two years, they can neither be compared with each other nor with those for 1902, except as regards the quantity and value of the production.

Table 1 is a summary of the statistics for 1902.

Table 1.—*Summary: 1902.*

Number of mines or quarries	4
Number of operators	4
Salaried officials, clerks, etc.:	
Number	7
Salaries	$2,628
Wage earners:	
Average number	23
Wages	$8,250
Miscellaneous expenses	$1,758
Cost of supplies and materials	$8,233
Product:[1]	
Quantity, short tons	2,505
Value	$46,200

Detailed statistics of this industry can not be published by states without disclosing the business of individual establishments, for, of the 4 mines or quarries reported, 1 each was located in Connecticut, Georgia, Massachusetts, and Virginia. Fifteen properties that were developed or prospected for asbestos in former years were idle in 1902. Three each of these were situated in Georgia, North Carolina, and Vermont, 2 in California, and 1 each in Pennsylvania, Virginia, Wisconsin, and Wyoming. Among the owners were 4 incorporated companies, with an authorized capital of $2,500,000, of which $1,655,070, all common, had been issued. Many of these properties, as those in North Carolina, Vermont, and Wyoming, contain the chrysotile variety, and it had been expected that some of these, especially those in Vermont, would report a marketable production for 1902.

Capital stock of incorporated companies.—Of the 4 operators in the asbestos industry, 3 were incorporated companies, 1 each of these being located in Connecticut, Georgia, and Virginia. In Table 2 are shown the details of their capital stock.

Table 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	3
Capital stock issued	$2,010,000
Total authorized—	
Number of shares	1,400,000
Par value	$2,300,000
Total issued—	
Number of shares	1,110,000
Par value	$2,010,000
Common—	
Authorized—	
Number of shares	1,100,000
Par value	$2,000,000
Issued—	
Number of shares	975,000
Par value	$1,875,000
Preferred—	
Authorized—	
Number of shares	300,000
Par value	$300,000
Issued—	
Number of shares	135,000
Par value	$135,000

None of the companies showed bonded indebtedness and none reported dividends. Of the authorized capital stock, 87.4 per cent of the total value had been issued, of which 6.7 per cent was preferred stock. The capital reported for this industry is extremely large when compared with the value of the production for 1902 and with the production for any of the past years since the industry was started. This is due to the fact that most of the companies sending their statistics for 1902 were organized during the past few years, when the methods of incorporation in vogue have been for highly capitalized companies, regardless of the real value of the property or plant or of the magnitude of the business that could be built up. The companies have been organized supposedly with the idea that the amphibole asbestos can be mined and manufactured and used for the same purposes as the chrysotile asbestos. Were this the case the capitalization would not be so much out of proportion to the value of the properties as it is. The capitalization given in the above statistics does not refer to asbestos companies manufacturing products from chrysotile asbestos imported from Canada, but to those mining asbestos in this country and manufacturing products directly from it.

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[1] The United States Geological Survey reports 1,005 short tons, valued at $16,200, which is the product marketed. Census figures represent the product mined.

Employees and wages.—Of the total amount, $10,878, reported as paid for salaries and wages, $8,250, or 75.8 per cent, was paid to the wage-earners, and $2,628, or 24.2 per cent, to the salaried employees. There were 5.8 wage-earners, on the average, to a mine. The average number of wage-earners, as may be seen by reference to Table 6, was greatest (61) during October and least (7) in June. The dull months were from January to July, both inclusive. Table 6 also shows the average number of wage-earners at each specified daily rate of pay. Of the 23 employees, 17 were classed as miners or quarrymen. Of these, 13 received from $1 to $1.24 per day; 1 received from $1.25 to $1.49 per day; and 3 received from $1.50 to $1.74 per day. There were 2 machinists or blacksmiths, 1 of whom received the highest rate paid, which was from $2.50 to $2.74 per day. There were 2 firemen, each of whom received from $1 to $1.24 per day. One other wage-earner, who did miscellaneous work, received from $1.50 to $1.74 per day. The prevailing rate of pay was from $1 to $1.24, 16 having received this rate. These comparatively low rates of pay are due to the fact that most of the miners were employed in the South, where the rates of pay are much lower than either in the North or the West.

Supplies, materials, and miscellaneous expenses.—The principal item of expense, next to that for wages, was for supplies and materials, for which $8,233 was reported as having been expended. The miscellaneous expenses of $1,758 were incurred for rent of office, taxes, insurance, and other sundries. Thus, the total cost, including wages, salaries, supplies, materials, and miscellaneous expenses, was $20,869.

Mechanical power.—Steam engines with a total of 105 horsepower were used in producing the asbestos, this power being reported by 2 establishments—1 in Georgia and 1 in Virginia.

Production.—The total production of asbestos in the United States for 1902 was 2,505 short tons, valued at $46,200. This production of asbestos is the largest reported during the period beginning with 1880, in which year the statistics for this mineral were first obtained. Of this production, however, 1,500 tons represents the rock just as mined. The statistics do not, therefore, represent the total value of the asbestos as it is put upon the market. In some instances the asbestos was crushed, separated, and otherwise prepared at the mines. As in such cases the mining and the processes to which the mineral is subjected were conducted under the same management and with the same capital, it is impracticable to separate the statistics. The United States Geological Survey has published annual statistics of the quantity and value of asbestos, and these are shown in Table 3, for the years from 1889 to 1902, inclusive.

TABLE 3.—*Production of asbestos: 1889 to 1902.*

[United States Geological Survey "Mineral Resources of the United States," 1902.]

YEAR	Quantity (short tons).	Value.	Average value per ton.
1889	30	$1,800	$60.00
1890	71	4,560	64.23
1891	66	3,960	60.00
1892	104	6,416	61.69
1893	50	2,500	50.00
1894	325	4,463	13.73
1895	795	13,525	17.01
1896	504	6,100	12.10
1897	580	6,450	11.12
1898	605	10,300	17.02
1899	681	11,740	17.24
1900	1,054	16,310	15.47
1901	747	13,498	18.07
1902	1,005	16,200	16.12

As is seen from the above table, there has been a very wide variation in the quantity reported from year to year, and also in the value. This is due, as stated above, to the uncertainty of the demand for this variety of asbestos. The highest prices were received for asbestos during the years from 1889 to 1893, when the values varied from $50 to $64.23 per ton. These high prices were undoubtedly due to the fact that certain manufacturers required only a few tons of asbestos, and in order to obtain these small quantities they were obliged to pay this increase in price. The total quantity of asbestos produced in the United States since 1880 amounts to only 10,917 tons, which would make an average production of 474 tons per year. The greatest quantity produced in one year was 1,200 tons in 1882, and the next greatest, 1,054 tons, in 1900. The average value varied from $64.23 in 1890 to $11.12 in 1897. In 1894 there was a decided drop in the value of amphibole asbestos, from $50 to $13.73, and since that time the average has not exceeded $18.07. In 1902 the values varied from $16 to $40 per ton, the latter price having been received for 5 tons of chrysotile asbestos which were obtained as a by-product in talc mining.

The detailed statistics of the asbestos industry for 1902 are shown in Table 6.

The quantity of the amphibole asbestos produced in the United States during 1902, and considered as used, was 2,500 tons, valued at $46,000, while the amount of chrysotile asbestos was valued at $762,632, of which only a quantity valued at $200 was produced in this country, the balance having been practically all imported from Canada. The imports, as published by the United States Geological Survey, are given in Table 4 for the years 1889 to 1902, inclusive.

TABLE 4.—*Value of asbestos imported: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING DECEMBER 31—	Unmanufactured.	Manufactured.	Total.
1889	$254,239	$9,154	$263,393
1890	252,557	5,342	257,899
1891	353,589	4,572	358,161
1892	262,433	7,209	269,642
1893	175,602	9,403	185,005
1894	240,029	15,989	256,018
1895	225,147	19,731	244,878
1896	229,084	5,773	234,857
1897	263,640	4,624	268,264
1898	287,696	12,807	300,503
1899	303,119	8,949	312,068
1900	331,796	24,155	355,951
1901	667,087	24,741	691,828
1902	729,421	33,011	762,432

Table 5 shows the production of asbestos from 1889 to 1902 in Canada, from which nearly all of the mineral used in the United States is obtained.

TABLE 5.—*Annual production of asbestos in Canada: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (short tons).	Value.
1889	6,113	$426,554
1890	9,860	1,260,240
1891	9,279	999,878
1892	6,082	388,462
1893	6,473	310,156
1894	7,630	420,825
1895	8,756	368,175
1896	12,250	429,856
1897	[1] 30,132	445,368
1898	[1] 23,785	486,227
1899	[1] 25,536	483,299
1900	[1] 30,641	763,431
1901	[1] 38,079	1,186,434
1902	[2] 40,416	1,148,319

[1] Including asbestic. [2] Including 10,197 tons of asbestic.

DESCRIPTIVE.

As is seen from the preceding tables and text, the asbestos mining industry in the United States is very small, and there is but little chance of its increasing, unless large deposits of the chrysotile asbestos are discovered and developed. There are very large deposits of amphibole asbestos, but, as already stated, there is not sufficient demand for this variety to create a large industry.

Although in many respects the two varieties are similar in physical properties, there is a wide variation in strength of fiber, the chrysotile variety being superior in both strength and elasticity to any amphibole asbestos, and for this reason capable of being used for many purposes for which the latter can not be adapted. With respect to their heat-resisting properties, they are about equal, so that when asbestos is to be used as an ingredient in fireproof paint, wall plaster, as boiler coverings, as packing, in the manufacture of fireproof safes, and for nearly all purposes in which nonconductivity of heat and not strength of fiber is the important factor, the amphibole variety can be used to as good advantage as the chrysotile. For these purposes there is probably but little chrysotile asbestos used, except what is known as asbestic or the waste portions. There are, however, a number of other minerals, such as infusorial earth, tripoli, talc, and mica, that are strong competitors of the amphibole asbestos.

On the other hand, where strength of fiber is essential as well as nonconductivity of heat, as in the manufacture of cloth, rope, felt boards, tubes, washers, and blocks of various shapes, it is only the chrysotile variety that can be used. The fibers of chrysotile are seldom over 2½ inches long, and are usually from one-half to 1½ inches in length. The fibers of the amphibole variety, however, occur up to 3 feet in length, and when this asbestos is fairly free from grit, it appears like a very attractive proposition. In a number of cases deposits of amphibole asbestos have been developed in attempts to compete with chrysotile, but in each case the effort has resulted in failure.

It is interesting to note the variation in the value of these two varieties of asbestos; for the amphibole variety there is usually simply the one flat rate, which has varied, since 1894, from $11.12 to $18.07 per ton. On the other hand, the chrysotile asbestos varies in price according to the different grades as follows:

	Per ton.
No. 1 asbestos	$150 to $250
No. 2 (white) asbestos	75 to 125
No. 3 (red) asbestos	50 to 75
Mill fiber, or paper stock	20 to 40
Asbestic	1 to 3

The mill fiber, or paper stock, is the minute fibers of asbestos which have become broken and are not capable of being used for weaving, and the asbestic is the final waste material, which contains a small amount of minute fibers and a considerable amount of the crushed serpentine rock.

Occurrence.—Since 1880 asbestos properties have been prospected and developed in the United States in Arizona, California, Georgia, Maryland, Massachusetts, Michigan, New Jersey, New York, Pennsylvania, South Carolina, Vermont, Virginia, and Wisconsin. Although a considerable search has been made for asbestos deposits in this country, it has resulted thus far only in the discovery of producing deposits of the amphibole variety.

At the present time the deposits of amphibole asbestos that are being worked or developed to any extent are as follows:

About 3 miles from the railroad station at New Hartford, Conn., a deposit of this asbestos occurs in a ledge that outcrops strongly for a distance of about 750 feet in length, with a width of 20 feet. It has been opened in a number of places to a depth of 45 feet. A plant for crushing and preparing this material for the market was being erected in 1902.

At Sal mountain, 12 miles northwest of Clarksville, Ga., are located the largest developed asbestos deposits in the United States.

In the northeast corner of Rabun county, Ga., and about 1½ miles from Russell, S. C., deposits of amphibole asbestos occur.

In Virginia, about 14 miles south of Bedford City, a deposit of amphibole asbestos occurs in seams and veins varying from 8 to 50 inches in thickness.

In Wisconsin, near Stevens Point, Wood county, a deposit of this asbestos has been developed, although no asbestos was produced during 1902.

Many other deposits of amphibole asbestos are known to exist in the United States, but unless they are very favorably located for mining, and have good transportation facilities, it is practically impossible to work them on a profitable basis.

Chrysotile asbestos has been found sparingly associated with many of the outcrops of basic magnesian rocks that extend northeasterly from Alabama across Georgia, South Carolina, North Carolina, Virginia, Maryland, Pennsylvania, the New England states, and into Canada. These rocks are more or less altered to secondary serpentine, and in the more northern sections different areas are often completely converted to this secondary rock, as those of Pennsylvania, Maryland, Vermont, and Quebec province in Canada, while in North Carolina, Georgia, and Alabama there are but very few areas that have been altered to this extent. As would be expected, it is only in those areas in which the rocks have been completely changed to serpentine that the chrysotile asbestos occurs in commercial quantity. Although only the very small amount of this variety of asbestos obtained from Massachusetts was produced from a mine already in operation, yet a great deal of work was done on deposits of this variety in Vermont and Wyoming, with a smaller amount of work on deposits in California, Michigan, and North Carolina.

The Vermont deposits are located in the north central part of the state, in the town of Eden, Lamoille county, and in the adjacent town of Lowell, Orleans county.

The Wyoming deposits, which are located in the vicinity of Casper, Natrona county, have been pretty thoroughly developed, but thus far operations have not been sufficiently advanced for the marketing of the product.

The deposits of California thus far developed are in Riverside county. The other deposits in this state and those in North Carolina, have been developed little more than to prove that the chrysotile asbestos is to be found.

The basic magnesian rocks of the Pacific slope, in California, Oregon, and Washington, have in many instances been entirely converted to secondary serpentine, and are promising fields for investigation. It is possible that when they are thoroughly prospected they will be found to contain deposits of the chrysotile asbestos capable of profitable operation.

TABLE 6.—*Detailed summary: 1902.*

Number of mines or quarries	4
Number of operators	[1]4
Character of ownership:	
Firm	1
Incorporated company	3
Salaried officials, clerks, etc.:	
Total number	7
Total salaries	$2,628
General officers—	
Number	2
Salaries	$900
Superintendents, managers, foremen, surveyors, etc.—	
Number	4
Salaries	$1,065
Clerks—	
Number	1
Salaries	$663
Wage-earners:	
Aggregate average number	23
Aggregate wages	$8,250
Above ground—	
Total average number	22
Total wages	$7,875
Engineers, firemen, and other mechanics—	
Average number	5
Wages	$2,079
Miners or quarrymen—	
Average number	16
Wages	$5,328
All other wage-earners—	
Average number	1
Wages	$468
Below ground—	
Total average number	1
Total wages	$375
Miners—	
Average number	1
Wages	$375
Average number of wage-earners at specified daily rates of pay:	
Engineers—	
$1.25 to $1.49	1
Firemen—	
$1.00 to $1.24	2
Machinists, blacksmiths, etc.—	
$1.00 to $1.24	1
$2.50 to $2.74	1
Miners or quarrymen—	
$1.00 to $1.24	13
$1.25 to $1.49	1
$1.50 to $1.74	3
All other wage-earners—	
$1.50 to $1.74	1
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	15
February	10
March	14
April	14
May	9
June	7
July	8
August	27
September	32
October	61
November	56
December	26
Miscellaneous expenses, total	$1,758
Rent of offices, taxes, insurance, interest, and other sundries	$1,758
Cost of supplies and materials	$8,283
Product:	
Quantity, short tons	1,005
Value	$16,200
Power owned:	
Total horsepower	105
Engines—	
Steam—	
Number	2
Horsepower	105

[1] Includes operators distributed as follows: Connecticut, 1; Georgia, 1; Massachusetts, 1; Virginia, 1.

ASPHALTUM AND BITUMINOUS ROCK

ASPHALTUM AND BITUMINOUS ROCK.

By Joseph Struthers, Ph. D.

Asphaltum became known to Census statistics in 1860, when it was reported from California among manufacturing statistics as "asphaltum work." At the census of 1870 no report was published from California, but an establishment in West Virginia was recorded in the statistics of mining as having produced asphaltum valued at $450,000. At the census of 1880 West Virginia dropped out and California returned statistics for two mines, being shown among mining industries. At the Eleventh Census, the inquiries for which, as to mining, covered the year 1889, asphaltum was shown among mineral industries in California, Kentucky, and Utah.

At the census of 1902 Arkansas, Indian Territory, and Texas were added to these, making 5 states and 1 territory reporting asphaltum. The asphaltum by-product of petroleum refineries, being the result of manufacturing processes, was included among manufactures at the census of 1900, with a number of other by-products, under the caption of "Residuum" in the Report on Petroleum Refining. This product is not, therefore, included in the statistics for 1902 herewith presented, which concern the mining of the various kinds of hydrocarbon rocks having an asphaltic base, namely, bituminous limestone and sandstone, and some of the purer forms of bitumen, as elaterite, gilsonite, and uintaite.

The comparative statistics from 1860 to 1902 are presented in the following table:

Table 1.—*Comparative summary: 1860 to 1902.*

	1902	1889	1880	1870	1860
Number of mines or quarries	24	(¹)	(¹)	(¹)	
Number of operators	24	(¹)	2	1	1
Salaried officials, clerks, etc.:					
Number	32	2	(¹)	(¹)	(¹)
Salaries	$48,233	$3,000	(¹)	(¹)	(¹)
Wage-earners:					
Average number	156	181	12	25	4
Wages	$79,570	$63,503	$2,220	$25,000	$3,600
Contract work	$10,000	$8,540	(¹)	(¹)	(¹)
Miscellaneous expenses	$19,733	$3,450			(¹)
Cost of supplies and materials	$21,928	$13,884		$26,771	$1,000
Product:³					
Quantity, short tons	66,258	51,735	111	50,000	(¹)
Value	$236,728	$171,537	$1,140	$450,000	$10,000

¹ Not reported. ² Not reported separately.

³ The United States Geological Survey reports 105,458 short tons, valued at $765,048, which includes the residual asphaltum product of petroleum refineries. This residuum being the product of manufacturing processes is not reported by the Census.

From 1860 to 1889 the production was quite irregular. The large increase in value of product from $10,000 in 1860 to $450,000 in 1870 was due to the discovery in West Virginia of a vein of grahamite, which was soon exhausted. A revival of the industry took place between 1880 and 1889. The increase in wages from 1889 to 1902 was $16,067, or 25.3 per cent, and the increase in value of product was $65,191, or 38 per cent. The 24 mines reported for the industry in 1902 were controlled by 19 incorporated companies, 3 individual proprietors, and 2 firms.

The state showing the largest production was California, with 35,377 tons, or 53.4 per cent of the total, and a value of $101,353, or 42.8 per cent of the whole.

Kentucky was second with 22,498 tons, or 34 per cent, and $68,704, or 29 per cent of the value. Indian Territory was third with 2,566 tons, or 3.9 per cent, and $11,754, or 5 per cent of the value. The remainder, 5,797 tons, or 8.7 per cent, and $54,917, or 23.2 per cent of the value, was for all other states, of which Utah was the largest producer, both in quantity and value.

Thirteen mines were idle—3 in California, 2 in Indian Territory, 2 each in Missouri, Texas, and Utah, and 1 each in Kentucky and Tennessee. There were 6 mines for which development work was reported but no production—3 in California, and 1 each in Arkansas, Colorado, and Indian Territory. The statistics for these are shown in the following statement:

Development work: 1902.

Number of mines or quarries	6
Number of operators	6
Salaried officials, clerks, etc.	
Number	5
Salaries	$5,160
Wage-earners.	
Average number	2
Wages	$1,050
Miscellaneous expenses	$1,662
Cost of supplies and materials	$72

Capital stock of incorporated companies.—The capitalization of 17 of the 19 incorporated companies, 2 failing to report in this particular, is shown in the following table:

TABLE 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	California.	Indian Territory.	Kentucky.	All other states.[1]
Number of incorporated companies	19	6	6	5	2
Number reporting capital stock	17	4	6	5	2
Capital stock issued	$9,760,700	$699,700	$725,000	$5,336,000	$3,000,000
Capital stock (all common):					
Authorized—					
Number of shares	130,000	16,000	23,500	60,500	30,000
Par value	$10,575,000	$700,000	$1,075,000	$5,800,000	$3,000,000
Issued—					
Number of shares	115,857	15,997	11,000	55,860	30,000
Par value	$9,760,700	$699,700	$725,000	$5,336,000	$3,000,000
Dividends paid	$13,000	$7,000	....	$6,000	....
Bonds:					
Authorized—					
Number	128	....	....	128	....
Par value	$110,000	....	....	$110,000	....

[1] Includes 1 company in Texas, and 1 in Utah.

The capital stock of the 5 Kentucky companies constituted 54.7 per cent of the total. The par value of the capital stock issued by the 17 companies reporting was 92.3 per cent of the total amount authorized. No bonds were issued and the par value of those authorized amounted to only $110,000, all in Kentucky.

The production of the active mines operated by the 19 incorporated companies, including the 2 companies not reporting their capital, was 59,448 tons, or 89.7 per cent of the total, and $201,346, or 85 per cent of the total value.

Employees and wages.—The wage-earners constituted 75 per cent of the salaried employees and wage-earners, and their wages were 62.3 per cent of the total salaries and wages. Kentucky led, with 41.7 per cent of the wage-earners and 28.4 per cent of the wages, California being second, with 20.5 per cent and 25.2 per cent, respectively. In addition to the amount paid in wages, $10,060 was paid to 60 employees for contract work.

As shown in Table 5, November was the month during which the largest number of wage-earners was employed in the industry, although employment was not very variable during the year. In Indian Territory the largest number is shown for December. The smallest number of wage-earners for all the states appears for June. Of the total number of wage-earners, 58, or 37.2 per cent, received from $1 to $1.24 per day, and 27, or 17.3 per cent, from $2.50 to $2.74 per day. Machinists, blacksmiths, carpenters, and other mechanics received the highest rate—from $4 to $4.24. Of the total wage-earners, 116, or 74.3 per cent, were miners or quarrymen. Fifty, or 43.1 per cent of these, received from $1 to $1.24 per day; 25, or 21.6 per cent, from $2.50 to $2.74; and 14, or 12.1 per cent, from $2.75 to $2.99. The 21 "all other wage-earners" were engaged in miscellaneous work about the mines and quarries.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials, reported as $21,928, is the largest item of expense other than wages and salaries. Of the $19,753 expended for miscellaneous expenses, $16,897, or 85.5 per cent, was paid for rent of offices, taxes, insurance, interest, and other sundries, and $2,856, or 14.5 per cent, for royalties, and rent of mine and mining plant.

Mechanical power.—Of the 24 operators from whom reports were received, 8 reported the use of power, the total of the primary power being 720 horsepower. Of this, 660 horsepower, or 91.7 per cent, was steam, and 60, or 8.3 per cent, gas or gasoline. There was, in addition, 1 electric motor having 25 horsepower. Kentucky reported 53.8 per cent of the steam power, and

Indian Territory 46.2 per cent of the steam and all of the electric power. The total gas or gasoline power was reported from California.

Production.—The United States Geological Survey has published annual statistics of the production of asphaltum since 1882, but these are not comparable with Census statistics, for the reason that after the year 1891 they include maltha, or brea, and the asphaltum by-products of petroleum refineries. During 1902 the quantity of by-product asphaltum produced by oil refineries in California and Texas, and sold and used in the trade as asphaltum, amounted to 20,826 short tons, valued at $303,249.[1]

According to the reports received for 1902, the average price of asphaltum was $3.57 per ton. The range was from $1.50 to $50, the former for less than 100 tons mined in Indian Territory, and shipped in the crude state, and the latter for less than 1,000 tons of elaterite mastic mined in Utah, f. o. b. at the mines.

Most of the imported asphaltum comes from the Island of Trinidad, British West Indies. The following table, compiled from tables published by the United States Geological Survey, shows the total imports into the United States from all countries since 1889. The values are at point of shipment:

Table 3.—*Crude asphaltum imported for immediate consumption: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR ENDING DECEMBER 31—	QUANTITIES.				Total value.
	From Trinidad.			From all countries (long tons).	
	Total (long tons).	Land (long tons).	Lake (long tons).		
1889	58,978	13,568	45,410	61,952	$158,163
1890	57,324	17,417	39,907	73,861	223,368
1891	73,027	20,517	52,510	102,433	259,850
1892	88,212	17,406	70,806	120,255	336,968
1893	68,886	3,450	65,436	74,774	196,314
1894	75,713	3,953	71,760	102,505	313,680
1895	69,720	4,744	64,976	79,557	[1] 210,556
1896	72,686	12,049	60,637	96,192	[1] 301,596
1897	93,650	19,243	74,407	115,528	[1] 392,770
1898	66,583	18,160	48,423	69,837	[2] 203,395
1899	95,941	25,164	70,777	108,171	[3] 425,263
1900	105,734	34,796	70,938	118,771	[4] 451,782
1901	112,216	31,767	80,449	138,833	[5] 553,473
1902	130,109	25,153	104,956	146,883	[6] 492,656

[1] In addition to the crude asphaltum imported in 1895, there was some manufactured or refined gum asphaltum, valued at $36,664. In 1896 the value of the manufactured asphaltum imported was $77,449, and in 1897, $25,095. The quantity was not reported.

[2] Includes 3,069 long tons, "dried or advanced," valued at $17,005.

[3] Includes 4,264 long tons, "dried or advanced," valued at $35,395.

[4] Includes 5,141 long tons, "dried or advanced," valued at $49,242.

[5] Includes 6,754 long tons, "dried or advanced," valued at $96,958.

[6] Includes 7,239 long tons, "dried or advanced," valued at $62,561.

Exports of crude asphaltum during 1902 amounted to 2,930 long tons, valued at $23,564.

The production of asphaltum and asphaltic rock in the principal producing countries of the world, from 1890 to 1901, inclusive, is given in Table 4.

Table 4.—PRODUCTION OF ASPHALTUM IN PRINCIPAL PRODUCING COUNTRIES: 1890 TO 1901.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	UNITED STATES.		TRINIDAD.		GERMANY.		FRANCE.		ITALY.		SPAIN.		AUSTRIA-HUNGARY.		RUSSIA.		VENEZUELA.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).
1890	40,841	$190,416	91,831	$254,019	59,361	$89,961	198,931	$555,092	49,728	$232,651	17	$91	......	......	......	......	......
1891	45,054	242,264	110,929	297,132	54,163	89,419	278,516	402,031	31,064	131,028	274	616	45	$258	15,471	$108,000	......
1892	87,680	445,375	129,438	347,310	58,713	99,686	216,848	323,851	38,107	162,308	64	1,014	18	288	20,838	118,760	......
1893	47,779	372,232	106,315	285,309	52,056	84,962	211,644	311,116	28,680	109,500	904	1,235	67	624	18,337	120,000	1,771
1894	60,570	353,400	121,186	324,606	61,691	107,250	254,582	339,241	66,663	270,854	1,085	1,989	2,740	75,026	17,706	176,400	7,751
1895	68,163	348,281	102,958	274,200	65,688	108,153	244,234	355,700	51,478	197,584	870	1,525	2,963	29,107	29,699	144,898	3,073
1896	80,503	577,563	110,667	296,457	67,830	107,908	219,032	326,013	50,092	151,507	1,231	2,156	5,149	72,159	29,043	133,141	6,197
1897	75,945	664,632	146,172	292,344	67,933	91,984	257,127	328,002	60,984	183,017	1,825	3,196	3,689	81,104	24,488	171,416	11,528
1898	76,337	675,649	112,220	653,800	75,550	99,088	252,558	322,117	103,312	296,347	2,603	4,606	4,152	86,018	13,244	128,176	Nil.
1899	75,085	553,904	153,870	745,242	82,397	123,984	285,208	356,719	90,350	222,519	2,801	4,964	6,256	79,654	25,435	170,300	12,014
1900	54,389	415,958	177,751	855,744	98,833	160,000	283,654	383,429	112,115	292,287	4,623	8,652	5,787	70,048	(1)	......	17,961
1901	63,134	555,335	191,488	799,010	99,420	168,750	275,216	372,989	114,761	261,761	4,361	8,137	3,770	68,140	(1)	......	24,378

[1] Statistics not yet available.

The detailed statistics of the industry in the United States for 1902 are shown in Table 5.

DESCRIPTIVE.

Asphaltum is the name applied to different forms of bitumen. Its composition varies, and it is known by many other names, bestowed on account of some special characteristic resulting from its composition or the locality from whence it has been obtained. The most common of these names are: Natural mineral pitch, Jews' pitch, Trinidad asphalt, Cuban asphalt, Dead sea bitumen, manjak, maltha, brea, chapapote, elaterite, wurtzilite, nigrite, gilsonite, grahamite, and uintaite.

Asphaltum has been an article of commerce from remote antiquity, the supply having been obtained from the deposits near the Dead Sea, where the material floated on the surface or was washed ashore by the waves, the product being known to the Arabs by the name of Hajar Mousa, or Moses's stone.

In Germany asphaltum was known as early as 1626 under the name of "harzerde" (pitch earth), which was described in 1692 by Doctor Amiest as asphaltum.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1902.

Bituminous limestone is mentioned by Doctor Erynis in several publications prior to 1721. The deposits at Seyssel, France, were discovered in 1802, and the asphaltum interests of France and Switzerland were united in 1832 by Count de Sassenay.

Physical and chemical characteristics.—Asphaltum ranges in form from the liquid maltha to the hard, solid glance pitch, which gradually merges into asphaltic coal. The specific gravity of pure asphaltum ranges from 1 to 1.3, and the hardness from 2 to 3. The solid varieties have a black or dark-brown color and a peculiar characteristic pitchy odor when rubbed.

Asphaltum breaks with a more or less splintery fracture and does not soil the fingers. It is very brittle at low temperatures, but upon being warmed, although it remains sufficiently hard to be broken by a sharp blow, at the same time it yields to a steady pressure or tread. Asphaltums differ much in their properties, and all do not possess the binding power so necessary for a lasting pavement; they shade by insensible gradations into brittle asphaltic coals. The melting point of asphaltum is usually low. It is very inflammable, burns with a yellow, smoky flame, and when pure leaves very little if any residue. It is insoluble in water, slightly soluble in alcohol and fixed and essential oils, and readily soluble for the greater part in ether, oil of turpentine, naphtha, and carbon bisulphide. With benzole it forms a solution of an intense black color, used as a varnish. When subjected to destructive distillation, asphaltum is decomposed into a distillate of oils and a tarry residue which becomes solid when cold.

The chemical composition of asphaltum is so complex that elementary analyses throw little light on the subject. It still remains an open question whether important groups of definite and characteristic hydrocarbons can be separated and recognized.

Many chemical analyses of asphaltum from various localities have been published from time to time which, however, are of scientific value only. Of these analyses the following are characteristic:

Analyses of pure asphaltum, exclusive of earthy matter and other mechanical impurities.

CHEMIST	Place	Total per cent	PER CENT OF—				
			Carbon	Oxygen	Hydrogen	Nitrogen	Sulphur
Bowen	Trinidad	100.00	85.89	0.56	11.06		2.49
Regnault	Mexico	100.00	80.34	10.09	9.57		
Boussingault	Peru	100.00	88.67	1.65	9.68		
Boussingault	Cuba	100.00	81.50	8.90	9.60		
Boussingault	Colombia	100.00	88.31	1.68	9.64	0.37	
Kayser	Palestine	100.00	80.00	0.40	9.00	10.00	0.60

Means other than chemical analysis are generally used to ascertain the commercial value of asphaltum. The first of these is a solubility test of the sample dried at 212° F. in various solvents, as carbon bisulphide, alcohol, turpentine, ether, petroleum, naphtha, etc. Distillation is often used and the losses at various temperatures are recorded. The quantity and quality of mechanical impurities (water, clay, earthy matter) contained in the sample are also determined; finally, the best test of its applicability for pavement purposes is its viscosity at various temperatures. In some cases the value of an asphaltum for use in pavement construction is determined by an actual trial.

The substances classed as bitumens are hydrocarbon compounds, the more important of which, arranged in the order of their specific gravities at 70° F., are divided into six groups:

1. Natural gas.
2. Natural naphtha.
3. Petroleum, or natural oil.
4. Maltha, or soft, sticky bitumen.
5. Asphaltum, or stiff, sticky bitumen.
6. Glance pitch, or dry, brittle bitumen (often called gilsonite).

In addition to the substances comprising the above list, there are other bitumens of chemical interest only, which possess no commercial value.

In commerce there are four chief classes into which asphaltum is divided: (1) The natural liquid form, called liquid asphaltum or maltha; (2) asphaltum mixed with more or less vegetable and earthy matter, which yields, by the removal of the mechanically contained impurities, the product called hard, refined, or gum asphaltum; (3) asphaltum contained in sand or sandstone, called bituminous sandstone; (4) asphaltum contained in limestone, called bituminous limestone.

In addition to the natural products given in the above list mention should be made of "by-product asphaltum," which is obtained in the refining of crude petroleum having an asphaltic base to yield commercial illuminating and lubricating oils. There is no strict line of demarcation between oils classed as petroleum oils and those considered as asphaltum oils.

The term bituminous rock is applied to both sandstones and limestones impregnated with asphaltum. Bituminous rock is sold and shipped without previous refining, and is consumed chiefly for street pavements, being generally mixed with other ingredients at the place of use. An inconsiderable proportion, however, is treated for its asphaltic content, the product being sold as refined or gum asphaltum.

Asphaltic or bituminous limestone is a natural compound of asphaltum and limestone, at times containing, in addition, other bituminous substances, sand, and sulphur-bearing compounds. The quantity of asphaltum present varies in different deposits, and even in different portions of the same deposit, up to 20 per cent. The grain of asphaltic limestone is extremely fine, and under the microscope each grain appears completely coated with asphaltum. It is this property which renders the natural product of greater value than an artificial mixture of asphaltum, fine sand, and pulverized limestone.

Analyses of representative asphaltic limestones, showing their general composition, are given below.

Analyses of representative asphaltic limestones, showing their general composition.

CHEMIST	Place	Total per cent.	PER CENT OF—						
			Asphaltum	Calcium carbonate.	Clay and iron oxide.	Sand	Magnesium carbonate	Insoluble matter.	Loss
Ponts et Chaus	Val de Travers	100.00	10.15	88.40	0.25	....	0.30	0.45	0.45
Ponts et Chaus	Seyssel	100.00	8.15	91.30	0.15	....	0.10	0.10	0.20
Ponts et Chaus	Ragusa	100.00	8.92	88.21	0.91	0.60	0.96	.....	0.40
Ver. lab.	Limmer	100.00	14.30	67.00	.....	[a]17.52	.....	..	1.18

[a] Includes clay and iron oxide and magnesium carbonate.

The formation of natural asphaltum is attributed by some geologists to the slow decay and decomposition of vegetable matter whereby the contained hydrocarbons have been distilled and subsequently condensed in the adjoining rocks, the product thus collected forming asphaltum deposits. The formation of artificial asphaltum in the manufacture of gas by the distillation of coal in a retort is quoted as a proof of this theory. In this process a considerable portion of tarry matter passes over and is collected during the distillation which yields, by a second distillation, naphtha and other volatile products, leaving as a residue in the retort a tarry substance possessing the properties of asphalt.

Other geologists claim that asphaltum is the result of the decomposition of certain petroleums under the influence of heat, accompanied by polymeric changes not fully understood, whereby the more volatile constituents of the oil are expelled, leaving the residue in the form of solid asphaltum.

Occurrence.—Asphaltum is seldom found native or pure, the principal known deposits containing it in admixture with other materials, chiefly earthy matter, sand, or sandstone and limestone. It occurs disseminated throughout many crystalline rocks, and is not restricted to any one geologic formation. It is not known, however, in the Archaean age. In many cases it has been deprived of volatile matter, which has caused it to resemble anthracite. It occurs also in veins that have been evidently injected into fissures, while in a plastic condition, exemplified by the minerals albertite and grahamite. It exists as a liquid in bituminous limestones and sandstones, from which it oozes, constituting the so-called "tar springs."

The most important of the liquid asphalt deposits are found in southern California, of which the Las Conchas mine on the ocean near Carpentaria has been operated successfully. The maltha impregnates a clean Quaternary beach sand of from 20 to 30 feet in thickness, overlying a bituminous shale, from which the liquid asphalt exudes. The crude sand containing about 20 per cent of bitumen is refined to a product of 95 per cent bitumen content. The refined liquid is used to soften solid asphaltum and to coat wood and masonry for protection against the penetration of moisture.

Asphaltum is found also in beds resulting from the oxidation either of mineral tar or, primarily, petroleum. This class includes the immense deposits at Tamaulipas and Moloacan, Mexico. There are many and diversified occurrences of asphaltum in Europe, the chief deposits being the bituminous limestones at Seyssel, France; at Val de Travers, in Neuchatel, Switzerland; in the Dinaric Alps, bordering the eastern coast of the Adriatic sea, and at Ragusa, Italy. In Asia it occurs at many localities in Syria, around the Dead sea, the source of the early supply of asphaltum.

The largest producing asphaltum deposit of the world is at Pitch Lake, on the island of Trinidad, where the asphaltum occurs in the form of a basin-shaped deposit 18 feet thick at the edges and 80 feet thick at the middle, with an estimated content of 6,000,000 tons of asphaltum. The deposit is supposed to be supported by water, and while solid enough to admit of the passage of wagon and horse, it has a slow movement which tends to draw in the tramway used to convey the excavated material to the shore of the lake, unless properly supported by branches of trees. In fact excavations of a depth of 20 feet have become filled in six months. The asphaltum is broken from the mass by means of picks, before daylight while the material is brittle; it is then loaded on cars and conveyed by the tramway to the shore, from whence it is carried to the pier, 3,500 feet distant, by an aerial wire-rope conveyor and dumped directly into the holds of the vessels. On the voyage it becomes agglomerated into a solid mass, which must be again broken up by pick in order to remove it from the vessel. The product is roughly refined by heating in tanks and straining the liquefied material through a screen for the separation of roots and other vegetable matter with which it is contaminated. There is a similar lake deposit near San Timolis, Venezuela, the product being known commercially as Bermudez asphaltum.

The principal deposits of natural asphaltum occur as shown in the following statement:

ASPHALTUM MIXED WITH EARTHY MATTER	ASPHALTIC LIMESTONE	ASPHALTIC SANDSTONE
United States:	United States:	United States:
California.	California.	California.
Colorado.	Indian Territory.	Colorado.
Indian Territory.	Michigan.	Indian Territory.
Montana.	New Mexico.	Kentucky.
Texas.	Texas.	New Mexico.
Utah.	Utah.	Texas.
Colombia.	Washington.	Utah.
Mexico.	Austria.	Cuba.
Palestine.	France.	France.
Peru.	Germany.	Germany.
Trinidad.	Hungary.	Russia.
Turkey in Asia.	Italy.	Spain.
Venezuela.	Russia.	
	Spain.	
	Switzerland.	

At the present time the chief producing localities are Trinidad, Dalmatia, Syria, Cuba, and the Seyssel, and Val de Travers deposits of bituminous limestones; local supplies of more or less value are obtained from other localities.

The following is a review by states of the asphalt industry in the United States during 1902:

Arkansas.—An asphaltum property near Pike City, Pike county, consists of a stratum of sand from 6 to 12 feet thick, containing various proportions of semifluid asphaltum. The product is obtained by sinking shallow pits, into which the material oozes from the bed. Borings have proved that the asphaltum beds extend over an area of several acres. A pit 100 feet in diameter has been dug, and a spur has been built to the railroad a half mile distant. A special feature of some portions of the bed is the occurrence of limestone with the sandstone, which yields a product available for paving purposes without the addition of other material.

The utilization of the asphaltum deposits in this state is solely a matter of cost of transportation. The average grade product should easily control the markets of Little Rock, Texarkana, and Fort Smith, and the higher grade material should compete advantageously with other asphaltum in cities as far distant as Memphis and St. Louis. It is also probable that pure asphaltum could be extracted from the asphaltic sandstone at a profit greater than that obtained by the sale of the crude product.

Analyses of samples of asphaltic rock from this district have been reported by Mr. C. W. Hayes,[1] as follows:

COMPONENTS	Gray banded rock (percent).	Brown capsand (percent).	Black sand rock (percent).	Black gummy rock (percent).	Calcareous sandstone (percent).
Petroleum	6.68	1.73	11.15	6.61	3.46
Asphaltene		3.53	2.40	2.25	1.12
Silica	62.18	92.40	81.20	79.80	49.42
Calcium carbonate	20.38			6.14	46.00

California.—On the Sisquoc ranch, Santa Barbara county, the principal asphaltum property is the mesa deposit, 1,300 by 5,000 feet in area and of a reported minimum depth of 125 feet, which is estimated to contain 25,000,000 tons of bituminous rock, equivalent to 5,000,000 tons of asphaltum. The rock is mined, elevated by an electric crane, and shipped in steel cars to the refinery works on the mountain side, where gravity is utilized to move the materials. The crude rock is crushed by steel rolls and heated in revolving steel-jacketed drums, and as it becomes softened by heat it is treated with gasoline until thoroughly saturated. It is then passed into a series of agitating drums, which separate the solution containing the asphaltum from the tailings; the solution flows by gravity to the stills, and the gasoline is removed and recovered for repeated use. The residue in the still, consisting of asphaltum of 99 per cent purity, is cooled and barreled for shipment.

The product of the companies operating these mines is chiefly a bituminous sandstone, largely utilized for paving purposes on the Pacific coast, where, owing to the simple method of its preparation and the cheap water freight rates, it competes successfully with other asphaltum paving mixtures. There is no production of asphaltic limestone in California worthy of mention. In addition to the producers of asphaltum from natural rock in this state, a large number of crude petroleum refineries have been established, which furnish a considerable quantity of by-product asphaltum obtained from the crude petroleum oils of California. By-product asphaltum possesses similar properties to that obtained from the rock deposits, and replaces it to a considerable extent in paving and other uses.

Indian Territory.—The known asphaltum deposits in this territory are almost entirely within the reservation of the Chickasaw nation. Development work has been started at Ravia, Dougherty, and Tar Springs, and at the two former localities soft asphaltic sands and a bituminous limestone have been mined, and at the last-named place asphaltic sandstone is produced. Grahamite is mined near Tar Springs, the product being hauled to Comanche, 18 miles distant, and then shipped by the Chicago, Rock Island and Pacific Railroad. Considerable prospecting by drills has been accomplished in the vicinity of Tar Springs, and other deposits of asphaltic sands have been found below the surface deposit, separated therefrom by beds of red and blue clay and shale. The thickness of the asphaltic sand beds varies from 3 to 20 feet, while the clay and the shale strata range from 5 to 40 feet in thickness. The lower limit of the asphaltic sand has been found at a depth of 600 feet from the surface. The present supply of asphaltum is obtained by open-cut working. The sandstone capping is removed by drilling and blasting, and the soft asphaltic sands are broken up by blasting and removed by plows and scrapers to the refinery, where the sterile sand is segregated by mechanical concentration with hot water. The asphaltic material rises to the surface and passes to the reducers, where it is brought to the proper consistency by the application of heat and subsequently strained and barreled for shipment. The products vary with the demands of the market, and range from a semiliquid on the one hand to a hard and brittle form on the other. Very little of the latter is made, however, on account of the large amount of time and fuel required to produce it.

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[1] Engineering and Mining Journal, December 13, 1902.

Kentucky.—The principal bituminous sandstone deposits in Kentucky are in Logan, Warren, Edmonson, Butler, Grayson, and Breckinridge counties, occupying an area of 20 by 50 miles in the central part of the state. The deposits are in fine-grained sandstone of the Subcarboniferous formation, and from geological evidence the asphaltum represents the residual matter from preexisting beds of petroleum. The numerous deposits in Grayson and Edmonson counties vary both in richness and magnitude, the range in the thickness of the beds being from 2 to 20 feet. But few of these deposits, however, are of commercial value. The richer deposits lie between strata of "black rock" from 1 to 2 feet thick, and the intervening asphaltum ledge varies in thickness from 3 to 15 feet and contains from 5 to 15 per cent of bituminous matter; below 4 per cent asphaltum content the material merges into "black rock."

Up to the present time only those deposits lying conveniently near railroad or river have been developed, and of such only those have been worked which offer the least difficulty in the way of uncovering. No tunneling or drifting has yet been attempted. At Bowling Green there is a 200-ton refining plant, equipped with corrugated rolls. The moisture in the material as it comes from the crushers is expelled by means of steam jets.

A property 4 miles northeast of Russellville, Logan county, has been developed quite extensively, the quarry face showing a 17-foot asphaltum ledge. The plant of this company includes a 250-ton gyratory crusher and plain 14 by 18 inch rolls. Quarries, mill, and tipple are connected by 1½ miles of narrow gauge track, and at the end of the year the rolling stock equipment consisted of 45 cars. At Louisville, the operating company has installed a plant for mixing and preparing asphaltum for street paving work, which has a daily capacity of preparing material to cover an area of 18,000 square feet.

An asphaltum company near Garfield, Breckinridge county, has a 100-ton plant. The asphaltic rock is broken in two sets of beaters revolving about horizontal shafts, the first making 600 and the second 1,200 revolutions per minute. The coarsely broken material from the first beater is passed to a 2-inch screen, the oversize being returned for a second treatment. The material passing through is treated in the second beater, which delivers to a screen. Material exceeding one-sixteenth of an inch in size is returned to the second beater for another treatment.

Texas.—There has been comparatively no appreciable production of asphaltum in this state in recent years. That reported in 1902 was liquid asphaltum.

Utah.—In recent years a small quantity of asphaltic limestone has been produced from deposits in the eastern part of the state, nearly the entire output being consumed in the local markets. The chief asphaltum product, however, is gilsonite (also called grahamite), which is mined about 60 miles from Vernal, Uinta county. Gilsonite is a very high grade material, of especial value for manufacture into varnishes, lacquers, paints, and similar products. On account of the high price it commands, the product can stand a long distance freight rate to chemical works.

Uses.—The principal use for asphaltum is in the construction of pavements. In addition, a considerable quantity is consumed for the manufacture of special varnishes; for waterproofing buildings and other objects as a protection against dampness; for coating vessels, as a protection against the teredo, or ship-boring worm; as an enamel for iron objects; for roofing purposes in the form of asphaltum or tar paper; for electric current insulation; and as an ingredient of cement.

Asphaltum sidewalks were first used in Paris in 1838, and to-day they extend to a distance exceeding in the aggregate 1,200 miles. The introduction of asphaltum pavements in the principal cities of the world is given by J. W. Howard[1] in the following chronological order: Paris, 1854; London, 1869; Budapest, 1871; Dresden, 1872; Hamburg, 1872; Berlin, 1873; followed shortly afterwards by Brussels, Geneva, Leipzig, Frankfort, and others. In the United States a so-called "tar-poultice pavement," composed of coal or gas tar, sand, etc., was laid in several cities during the period from 1870 to 1873, and in 1871 to 1873 successful experiments were carried out with an artificial asphaltic sandstone pavement in New York, N. Y., and in Newark, N. J. In 1878 a pavement composed of Trinidad asphaltum, sand, and powdered limestone was successfully introduced in Washington, D. C., and has since been the standard pavement of that city. At the present time more than a hundred of the principal cities of the United States have adopted some form of asphaltum pavement.

In making asphaltum pavement the general procedure is to grade the street to be paved, roll it with a steam roller, and then cover it with a layer of cement concrete 5 or 6 inches thick; or in case the street is macadamized or paved with stone blocks, the concrete is unnecessary. In the latter cases a thin layer of asphaltum concrete from 1 to 1.5 inches thick is laid directly upon the old surface. The foundation having been thus prepared, the asphaltum paving mixture, called the "wearing surface," is then spread over it with heated rakes to the desired thickness, which varies from 1.5 to 2.5 inches, depending upon the traffic to pass over it.

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[1] The Mineral Industry, Vol. II, page 51, et seq.

The ordinary Trinidad asphaltum paving mixture is made by adding and thoroughly mixing with hot refined asphalt about 15 per cent of its weight of residuum oil, the mixture serving to cement together the sand and powdered limestone which enter into the paving mixture. The proportions of the ingredients vary according to their physical and chemical quality, as well as to the climate in which the pavement is to be used, hot climates requiring less cement than cold. A typical pavement is composed of from 15 to 18 per cent of asphaltic cement, from 70 to 83 per cent of sand, and from 5 to 15 per cent of limestone.

For use in making pavements, the mined asphaltic limestone is crushed into pieces not exceeding 2 inches in diameter, and then reduced to about 10-mesh size in a ball or centrifugal pulverizer. The fine material is heated to 275° F. in heaters, spread over the prepared roadbed, and compressed by heated rammers, or otherwise, until it is of a thickness of from 2 to 2.5 inches. This form of pavement is not popular in places subject to fogs, rains, and low temperatures, for the reason that it becomes polished and slippery when wet, or dry in cold weather. In Paris and Berlin large supplies of sand are kept near the streets paved with asphaltic limestone for use during fog, slight rain, or snow.

Pavements made with Trinidad or other asphaltum in which sand, in proportions up to 80 per cent, is the chief ingredient, do not become slippery except when covered with ice; the sand makes them gritty and not susceptible to polish.

For the manufacture of black varnish, used chiefly for coating ironwork, pure asphaltum is dissolved in benzole or liquids containing benzole. The asphaltum from Syria is used for this purpose. By covering hot iron with asphaltum varnish the volatile ingredients of the latter are driven off, leaving a residual coating in the form of a smooth and polished enamel.

For insulating and cementing purposes asphaltum forms a very important ingredient on account of its wonderfully adhesive quality.

For waterproofing foundations of brick or stone, asphaltum is dissolved in petroleum and laid in the form of a cement or mortar, forming a very durable waterproof coating.

For making cement, petroleum residue is added to asphaltum in order to render it plastic, and from 5 to 10 per cent of sharp sand is mixed with it, according to the purpose for which it is to be used.

For roofing purposes asphaltum is used to a very large extent in admixture with coal tar, pitch, or petroleum residue; the material being used to saturate two or three thicknesses of felt, which are finally compressed into one compact sheet. The tar or roofing felt is held in place by nails driven through tin disks, and the whole completely covered with cement similar in composition to that used in making the felt; while this is still soft a covering of sharp sand, or screened gravel, is spread over the surface, forming a tight roof of great durability.

Asphaltum refining.—There are various methods used for the refining of asphaltum, depending on the nature of the crude material and the use to which it is to be applied. In general, with high grade material, the treatment has for its object the removal of water, volatile hydrocarbons, and mechanically suspended mineral and vegetable matter, but with asphaltums to be used in pavement construction it is essential to allow the mineral matter to remain in the product, for the reason that the asphaltum in this case is to serve solely as a binding and waterproofing material. In fact, asphaltic rock of the proper composition is not refined before use, but merely crushed, heated, and laid in place. The simplest method of extracting asphaltum from its compounds is by boiling in water, which causes the lighter asphaltum to rise to the surface, from whence it can be easily removed. Common salt or calcium chloride may be substituted for water in the treatment of material requiring a higher temperature or a heavier supporting liquid. In other cases asphaltum is extracted by means of a solvent, such as carbon bisulphide or naphtha, and obtained from the solution by heating in stills, which causes the volatile solvent to be distilled for repeated use and leaves the liquid asphaltum residue in a practically pure condition.

TABLE 5.—DETAILED SUMMARY: 1902.

	United States.	California.	Indian Territory.	Kentucky.	All other states.[1]
Number of mines or quarries	24	9	6	5	4
Number of operators	24	9	6	5	4
Character of ownership:					
Individual	3	2			1
Firm	2	1			1
Incorporated company	19	6	6	5	2
Salaried officials, clerks, etc.:					
Total number	52	3	5	32	12
Total salaries	$48,233	$8,280	$4,410	$17,420	$18,123
General officers—					
Number	23	1	2	14	6
Salaries	$27,700	$4,800	$2,400	$8,300	$12,200
Superintendents, managers, foremen, surveyors, etc.—					
Number	17	1	3	10	3
Salaries	$15,013	$2,400	$2,010	$6,370	$4,233
Foremen below ground—					
Number	1				1
Salaries	$1,240				$1,240
Clerks—					
Number	11	1		8	2
Salaries	$4,280	$1,080		$2,750	$450
Wage-earners:					
Aggregate average number	156	32	28	65	31
Aggregate wages	$79,570	$20,031	$13,185	$22,574	$23,780
Above ground—					
Total average number	140	32	26	65	17
Total wages	$66,709	$20,031	$11,922	$22,574	$12,182
Engineers, firemen, and other mechanics—					
Average number	17		6	9	2
Wages	$10,784		$3,334	$4,900	$2,550
Miners or quarrymen—					
Average number	101	27	11	48	15
Wages	$47,850	$18,156	$4,644	$15,418	$9,632
All other wage-earners—[2]					
Average number	22	5	9	8	
Wages	$8,075	$1,875	$3,944	$2,256	
Below ground—					
Total average number	16		2		14
Total wages	$12,861		$1,263		$11,598
Miners—					
Average number	15		1		14
Wages	$12,070		$472		$11,598
Miners' helpers—					
Average number	1		1		
Wages	$791		$791		
Average number of wage-earners at specified daily rates of pay:					
Engineers—					
$1.25 to $1.49	2			2	
$2.00 to $2.24	2		2		
$2.50 to $2.74	2			2	
Firemen—					
$1.25 to $1.49	2			2	
$1.75 to $1.99	1		1		
$2.00 to $2.24	1		1		
Machinists, blacksmiths, carpenters, and other mechanics—					
$1.75 to $1.99	1			1	
$2.00 to $2.24	3		1	2	
$4.00 to $4.24	2				2

	United States.	California.	Indian Territory.	Kentucky.	All other states.[1]
Average number of wage-earners at specified daily rates of pay—Con.					
Miners or quarrymen—					
$1.00 to $1.24	50		5	45	
$1.25 to $1.49	11	8		3	
$1.50 to $1.74	11	2	4		5
$1.75 to $1.99	2	1	1		
$2.00 to $2.24	3	2	1		
$2.50 to $2.74	25	14	1		10
$2.75 to $2.99	14				14
Miners' helpers—					
$1.75 to $1.99	1		1		
Timbermen and track layers—					
$2.00 to $2.24	1		1		
All other wage-earners—					
$0.75 to $0.99	2		2		
$1.00 to $1.24	8			8	
$1.25 to $1.49	6	5	1		
$1.50 to $1.74	4		4		
$1.75 to $1.99	1		1		
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	140	28	25	61	26
February	139	28	24	61	26
March	146	28	27	65	26
April	140	28	29	57	26
May	132	28	23	55	26
June	129	28	23	52	26
July	141	32	21	62	26
August	157	41	25	62	29
September	164	41	30	64	29
October	189	52	27	64	46
November	192	52	29	65	46
December	180	52	30	52	46
Contract work:					
Amount paid	$10,066		$1,025		$9,041
Number of employees	60		6		54
Miscellaneous expenses:					
Total	$19,753	$1,185	$2,213	$11,948	$4,407
Royalties and rent of mine and mining plant	$2,856	$800	$796		$1,260
Rent of offices, taxes, insurance, interest, and other sundries	$16,897	$385	$1,417	$11,948	$3,147
Cost of supplies and materials	$21,928	$1,370	$6,280	$7,350	$6,928
Product:					
Quantity, short tons	86,238	55,477	2,556	22,408	5,797
Value	$236,728	$101,343	$11,754	$68,704	$54,927
Power owned:					
Total horsepower	720	60	605	55	
Engines—					
Steam—					
Number	11		7	4	
Horsepower	655		600	55	
Gas or gasoline—					
Number	1	1			
Horsepower	60	60			
Electric motors—					
Number	1		1		
Horsepower	5		5		

[1] Includes operators distributed as follows: Arkansas, 1; Texas, 1; Utah, 2.

[2] Includes timbermen and track layers.

BAUXITE

BAUXITE.

By Joseph Struthers, Ph. D.

While the production of bauxite in the United States on a commercial scale dates from the opening of the deposits in the state of Georgia during 1889, the mineral does not appear to have been produced in sufficient quantities to be included in the reports of the Eleventh Census. This report, therefore, contains the results of the first census of the mining of bauxite in the United States. Table 1 is a summary of the statistics for 1902.

Table 1.—*Summary: 1902.*

Number of mines or quarries	38
Number of operators	7
Salaried officials, clerks, etc.:	
Number	42
Salaries	$33,250
Wage-earners:	
Average number	150
Wages	$59,763
Contract work	$500
Miscellaneous expenses	$11,939
Cost of supplies and materials	$40,019
Product:	
Quantity, long tons	29,222
Value	$128,206

Of the 38 mines or quarries for which production was reported, 3 were in Alabama, 19 in Arkansas, and 16 in Georgia. The entire number was controlled by 7 operators, of whom 5 were incorporated companies and 2 individual owners. There were 34 mines operated by 3 incorporated companies, 1 company controlling 19, another 10, and another 5 mines. There were 2 companies and 2 individual owners operating 1 mine each. This centralization of the industry makes it impossible to publish the statistics for the different states without disclosing the operations of individual companies; therefore, only the totals for the United States are presented. One mine in Arkansas was reported idle in 1902.

Capital stock of incorporated companies.—A considerable portion of the total production of bauxite was mined by establishments that were engaged in mining operations as incidental to the manufacture of aluminum, paint, and chemical products. The capitalization of these companies represents both their mining and manufacturing industries and, therefore, is not included in this report. Of the 5 incorporated companies, 3 reported that they were engaged primarily in mining. Their authorized capitalization consisted of 2,500 shares of common stock with a par value of $225,000. Of this amount, 1,730 shares, valued at $148,000, had been issued at the close of the year covered by this investigation. No dividends appear to have been paid on this stock during the year.

Employees and wages.—The variation in the number of wage-earners employed during the different seasons of the year and the specified daily rates of pay are shown in Table 4. The height of activity in the industry appears to have been reached during the month of May, when an average of 168 wage-earners was reported. The smallest number, 132, was given for the month of December. The slight variation in the number employed during the entire year indicates a uniform production.

The mining of bauxite requires no particular skill on the part of the miner, and the rates of pay should not be compared with those reported for miners of other minerals where skill and experience are necessary. Of the total number of wage-earners, 77, or 51.3 per cent, were classed as miners. Of this number the wages for 64 ranged from $1 to $1.24 per day. The rates for "all other wage-earners," which includes those engaged in assorting, grading, handling, loading, and hauling the ore and in miscellaneous work in connection with the mining or quarrying of bauxite, were considerably higher than the rates reported for miners. Of the 53 reported for this class, 40 received from $1.50 to $1.74 per day. The rate of pay at which the greatest number of wage-earners was employed is from $1 to $1.24 per day, 69 having been paid at this rate. One hundred and thirty-four, or 89.3 per cent of all wage-earners, received from $1 to $1.74 per day. This uniformity in the rates of pay is due largely to the fact that 69 wage-earners, or 46 per cent of the total number, were reported by 2 operators working on a large scale.

The extraction of bauxite is from open cuts, no tunneling being required, and all of the employees, therefore, were reported as engaged above ground. The 150 wage-earners give an average of 3.95 to each mine, but it is probable that all of the mines were not operated during the entire year. In addition to these wage-earners, 10 others were reported as employed by contractors to whom the sum of $500 was paid.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials constitutes an important item of expense in connection with the operation of bauxite mines. The total amount, $40,019, reported for supplies and materials probably includes a considerable proportion of the expenses incident to development work and the installation of new plants and machinery; it includes also the amount spent for supplies used in connection with the calcination of the crude bauxite. The total amount, $14,939, reported as miscellaneous expenses, includes amounts paid for legal services and other miscellaneous items, some of which are not strictly applicable to the operation of the mines.

Mechanical power.—Of the 7 operators from whom returns were received, 6 reported power, all of it owned, for the operation of their mines. The total primary power amounted to 624 horsepower, of which 575 horsepower was supplied by 19 steam engines and 49 horsepower by 2 gas or gasoline engines. There were also 4 electric motors with 64 horsepower.

Production.—The total production for the calendar year 1902, as shown by Table 1, was 29,222 long tons, valued at $128,206. The United States Geological Survey has published annual statistics concerning the quantity and value of bauxite. Table 2 shows the totals for each year since 1889. Since the economic importance of bauxite is due almost exclusively to its use in the manufacture of the metal aluminum, aluminum sulphate, common alum, and artificial emery, this table has been prepared so as to show the available figures for the manufacture of these substances. Statistics for the production of sodium aluminate and other salts that contain aluminum can not be secured.

For all practical purposes the yearly supply of bauxite in the United States, including both domestic production and imports less exports, may be taken as the equivalent of yearly consumption. The aggregate value of the aluminum and alum aluminum sulphate made from bauxite during 1902 amounted to $4,522,761.

TABLE 2.—PRODUCTION, IMPORTS, EXPORTS, AND CONSUMPTION OF BAUXITE AND THE PRODUCTION AND VALUE OF ALUMINUM, 1889 TO 1902, AND OF ALUM AND ALUMINUM SULPHATE, 1889 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	TOTAL DOMESTIC PRODUCTION.		BAUXITE, IMPORTS.		EXPORTS.		CONSUMPTION.		ALUMINUM, PRODUCTION.		ALUMINUM SULPHATE, PRODUCTION.		ALUM, PRODUCTION.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1889	728	$2,366	12,922	$60,292	.....	.....	13,650	$62,658	47,468	$97,335	.....	.....	.....	.....
1890	1,844	6,012	12,278	46,147	.....	.....	14,122	52,159	61,281	61,281	.....	.....	.....	.....
1891	3,593	11,675	8,021	46,242	.....	.....	11,614	57,917	150,000	100,000	.....	.....	.....	.....
1892	10,518	34,183	5,716	57,948	.....	.....	16,234	92,131	259,885	172,824	.....	.....	.....	.....
1893	9,179	29,507	5,103	28,217	.....	.....	14,282	57,724	333,629	266,903	.....	.....	.....	.....
1894	11,066	35,818	1,028	6,661	.....	.....	12,094	42,479	550,000	316,250	.....	.....	.....	.....
1895	17,069	44,000	5,797	34,782	.....	.....	22,866	78,782	920,000	464,600	.....	.....	.....	.....
1896	18,364	47,338	2,119	10,477	.....	.....	20,483	57,815	1,300,000	520,000	.....	.....	.....	.....
1897	20,590	57,652	2,645	10,515	2,537	$5,074	20,698	63,093	4,000,000	1,500,000	.....	.....	.....	.....
1898	25,149	75,437	1,201	4,238	1,000	2,000	25,350	77,675	5,200,000	1,716,000	76,625	$1,136,675	18,791	$561,730
1899	35,280	125,598	6,666	23,768	2,030	4,567	39,916	144,799	6,500,000	2,112,500	81,805	2,105,139	27,276	848,500
1900	23,184	89,676	8,656	32,967	1,000	3,000	30,840	119,643	7,150,000	1,920,000	63,078	1,480,273	19,537	615,930
1901	18,905	79,914	18,313	67,107	1,000	3,000	36,218	144,021	7,150,000	2,238,000	71,721	1,735,211	7,775	232,250
1902	29,222	128,206	15,790	54,410	Nil	.....	45,012	182,616	7,300,000	2,284,590	80,075	2,008,671	8,529	229,500

At the present time most of the bauxite in this country is used as a source of alumina from which the metal aluminum is made. The quantity used in the manufacture of chemical salts is relatively small. Thus the development of the bauxite industry depends to a great extent on the manufacture of aluminum and on the increased use of this metal for purposes of construction requiring lightness and no especial strength. Aluminum is also used as a substitute for copper as a conductor of electricity.

The largest production of bauxite is in France. Next to France ranks the United States, and third comes the United Kingdom, of which Ireland furnishes the output. Table 3 shows the production of the three nations mentioned, for 1900 and 1901, as reported by the United States Geological Survey.

TABLE 3.—*World's production of bauxite: 1900 and 1901.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

COUNTRY.	1900		1901	
	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
Total	87,960	$189,022	106,184	$218,797
United States	23,556	89,676	19,207	79,914
France	58,530	92,596	76,620	123,168
United Kingdom	5,874	6,750	10,357	15,715

The total quantity of bauxite produced in the United States since the beginning of operations in 1889 amounts to 224,691 tons, or an average production of 16,049 tons per year. The greatest quantity produced during one year, 35,280 tons, was reported for 1899. There has been considerable variation in the average price per ton of bauxite, the range having been from $2.58 to $4.38. According to the reports received for 1902, the price varied from $2.50 to $6.50 per ton.

A detailed summary showing the statistics for the production of bauxite during 1902 is given in Table 4.

DESCRIPTIVE.

Occurrence.—The mineral bauxite was first discovered in the year 1821 near Baux, France, by the well-known French chemist, Berthier. He attempted to utilize it in the manufacture of alum, but, because of the large proportion of iron oxide it contained, he was unsuccessful. Later a deposit of the white variety, of greater purity than that of Baux, was discovered at Herault, also in France. The mineral did not, however, become of commercial importance until 1868 or 1869, when Sainte-Claire Deville, a French scientist, in the course of his experiments in the manufacture of aluminum, discovered the value of bauxite as an ore of this metal.

In 1881 occurred the first recorded discovery of bauxite in the United States. The find was made by Edward Nichols, at Hermitage, Floyd county, Ga. Afterwards deposits were found in Polk, Bartow, Gordon, and Chattooga counties. In 1891 R. S. Perry reported the discovery of the mineral in Calhoun county, Ala., although it had previously been found in that state in Cherokee county, where it had been known as iron-ore blossom and as Clinton fossiliferous iron ore. Other deposits were afterwards found in Cleburne county. In 1891, too, the mineral was reported by the Arkansas geological survey as having been found in Saline and Pulaski counties of that state. Other deposits have been found, notably in North Carolina, South Carolina, and New Mexico, but they are too limited in extent, and are too far from transportation facilities, or else contain too many impurities to be of value commercially. Arranged in the order of their outputs, Georgia, Alabama, and Arkansas furnish the total production of the United States.

The mining of the ore in this country is of comparatively recent inception, and, quite naturally, it has not reached a high state of efficiency. The mines are irregular holes dug in the hillsides, with deep, open drainage ditches leading from them. Below the surface the ore is sufficiently soft to be removed with pick and gad, which renders the extraction easy and lessens the cost of production. For a high grade product, however, the uneven quality of the ore makes necessary a sorting by hand or by screens. Screen sorting is generally preferred to hand sorting when the character of the ore will admit of the use of the screen. During the sorting process, when clay is mixed with the bauxite, a common log washer is occasionally used to separate it. The sorted product is then dried in the air or in kilns or furnaces prior to its shipment to market. In this process very satisfactory results have recently been secured from the use of furnaces of the revolving cylindrical type.

Refining was formerly done almost exclusively in Pennsylvania and New York, but recently new refining plants have been erected at Bauxite, in Saline county, Ark., and near East St. Louis, in St. Clair county, Ill. These plants are equipped with modern machinery, and hand labor has been superseded wherever practicable.

France produces three varieties of bauxite: The white of Herault; the pale of Baux and other localities of southern France; and the red, which contains a large proportion of iron oxide, and which is also found in several places in southern France. Of these, the white variety is the purest, containing from 65 to 74 per cent of alumina, from 0.25 to 3 per cent of ferric oxide, and from 12 to 18 per cent of silica. Thus it is comparatively free from iron oxide but contains a relatively large amount of silica. The most impure is the red variety, which contains from 50 to 62 per cent of alumina, from 24 to 28 per cent of ferric oxide, which imparts the red color, and from 1 to 7 per cent of silica. French bauxite is used chiefly in the manufacture of alum and alumina—the white variety, containing but little iron oxide, for alum; and the red variety containing but little silica, after purification, for alumina. Because of the low cost of mining and the low ocean freights of recent years, large quantities of this mineral have been brought to the United States and consumed, mainly for the manufacture of alumina from which metallic aluminum has been made. At the present time there is little, if any, French bauxite used for the manufacture of aluminum sulphate.

In the United Kingdom there are important deposits at Strain, near Ballyclare, and at Glenravel, both in county Antrim, Ireland. Of the European deposits, these are next in importance to those of France. An extensive use of this mineral of county Antrim for the manufacture of aluminum has been retarded, because the high percentage of silica it contains renders it inferior for this purpose to the bauxite of France. It is, however, of excellent quality and contains but little iron oxide or titanic oxide. Much of the product of the Irish mines is consumed in England, where it is made into alum.

In Germany there are several deposits of bauxite of considerable extent, but the quality is inferior to that of the French mineral. In one locality, however, the mineral is quite pure, but the deposit is too small in extent to be commercially valuable.

Austria, Italy, Asia Minor, French Guiana, and New South Wales also possess deposits of the mineral, but as yet none has been developed to the productive stage.

The following statement shows the analyses of specimens from various localities. This statement has been compiled from a large number of analyses which have produced results so varied that the extreme limits of each constituent have been presented. The average quantity of alumina (Al_2O_3) contained in marketed bauxite is practically 58 per cent.

Analyses of specimens of Bauxite from various countries.[1]

LOCALITY.	Alumina, Al_2O_3 (per cent).	Ferric oxide, Fe_2O_3 (per cent).	Silica, SiO_2 (per cent).	Calcium carbonate, $CaCO_3$ (per cent).	Titanium oxide, TiO_2 (per cent).	Water, H_2O (per cent).
France	30.3 to 75	0.1 to 48.8	0.3 to 2.2	0 to 12.7	1.6 to 4	12 to 22.1
Ireland	43.4 to 73	1.96 to 4.25	2.15 to 15.05			18.66 to 40.33
Germany	44.4 to 76.3	2 to 42.9	1 to 44.76			9.7 to 32.33
Austria	58 to 67.6	0.7 to 30	5.9 to 14.4			12.2 to 23.1
Italy	47.4 to 58.9	18.62 to 36.98	2.48 to 4.06		1.27 to 2.86	10.17 to 22.4
Georgia, United States	39.75 to 82.38	0.21 to 13.5	1.34 to 35.88		0.87 to 4.18	16.14 to 32

[1] Compiled from "The Mineral Industry," Vols. I to XI, inclusive.

Chemical properties.—The mineral bauxite is a hydrated aluminum oxide containing also various quantities of iron oxide (Fe_2O_3) and silica (SiO_2). Three varieties are distinguished, the monohydrate ($Al_2O_3.H_2O$), the dihydrate ($Al_2O_3.2H_2O$), and the trihydrate ($Al_2O_3.3H_2O$). Apart from impurities the composition of these minerals varies from the monohydrate (diaspore), which contains 85.12 per cent of Al_2O_3 and 14.88 per cent of H_2O, to the trihydrate (gibbsite), which contains 65.61 per cent of Al_2O_3 and 34.39 per cent of H_2O. More or less of the alumina in bauxite is replaced by iron or manganese oxides. Silica occurs in the mineral either free or in combination in clay. Minor impurities are compounds of phosphoric acid, sulphur, carbon dioxide, lime, and magnesia. In composition the French mineral appears to correspond to the monohydrate while that of the United States approximates the trihydrate. The composition of bauxite can be determined only by chemical analysis since it is not indicated by the physical properties of the mineral. According to Francis Laur,[1] the average composition is from 66 to 69 per cent of Al_2O_3; 27 per cent of H_2O, SiO_2, and F_2O_3; with from 3 to 4 per cent of TiO_2 and other impurities. In general the value of the ore is in direct proportion to the richness and purity of the alumina content. In ore of good quality the percentage of alumina is high, while that of iron oxide and silica is low. Bauxite has a strong affinity for water, which makes it necessary that the ore be dried before shipment. For the manufacture of aluminum the presence of iron oxide and titanic oxide in the ore is not objectionable, but for making alum these insoluble materials should not exceed 7 per cent, and the iron oxide should be less than 2.75 per cent. The trihydrate, on account of its greater solubility, is best suited for the manufacture of alum, and for this purpose the bauxite of the United States is preferable to that of France.

Physical properties.—Bauxite occurs in the earth's crust in the form of veins, beds, or amorphous masses, not crystallized, and without any constant organoleptic characteristics. The hardness, color, texture, and density often change in the same deposit. Usually the ore occurs in concretionary or pisolitic masses, although it is sometimes a hard, compact, homogeneous fine-grained rock. In some cases the structure is oolitic, and in others it is earthy, resembling clay. It may be hard or soft and compact or porous. The color varies from almost pure white to a deep red or black, passing through shades of cream, gray, yellow, and pink. The mineral is sometimes speckled or mottled, and is more or less stained by iron oxide, manganese minerals, or organic matter. The colors shade into one another gradually or abruptly, and seldom, if ever, does a deposit possess a uniform color. The hardness of average good ore varies from 1 to 3 and the specific gravity from 2.4 to 2.55.

When exposed to extreme heat bauxite becomes so hard that it is almost impossible to make any impression upon it with steel tools. This property in connection with its infusibility makes it an excellent material for crucibles and for furnace linings, since it resists chemical and calorific actions. The chief reason why bauxite is not used more extensively as a basic furnace lining is due to the impurities that are usually present in the mineral.

IMPORTANT PRODUCTS DERIVED FROM BAUXITE.

Four principal substances are prepared from bauxite, viz, aluminum sulphate, alum, artificial emery, and aluminum hydroxide. From the last-named substance the metal aluminum is manufactured.

Aluminum sulphate—$Al_2(SO_4)_3.18H_2O$.—This is a chemical salt technically known as "concentrated alum." It is prepared by decomposing bauxite with sulphuric acid. If the mineral is dissolved directly in the acid, the product will contain a large quantity of iron, forming the so-called "alumino-ferric cake," which is used for many purposes where iron and free acid are not objectionable, as in the precipitation of sewage and of waste liquors from dyeworks. Pure aluminum sulphate is now generally prepared by the Bayer process, which consists in adding powdered alumina to the solution of sodium aluminate, containing 1 part of Al_2O_3 to 1.8 parts of Na_2O. The reaction causes a crystalline precipitate of aluminum hydroxide. The silica and the iron present remain dissolved in the solution. The precipitated aluminum hydroxide is separated from the solution and is thoroughly washed and later dissolved in pure, hot, concentrated sulphuric acid until the frothing ceases. The solution is then transferred to shallow leaden pans and allowed to cool; thus the pure aluminum sulphate is separated out in the form of a solid crystalline mass. Owing to its greater purity and greater strength, aluminum sulphate has largely replaced alum in the arts. Aluminum sulphate is extensively used as a mordant in dyeing; in preparing size for paper; for making alum and aluminum salts (red liquor, etc.); in tawing skins; for precipitating sewage or coloring matter in water; and, in general, for all purposes in which alum was formerly used.

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[1] Transactions of the American Institute of Mining Engineers, Vol. XXIV (1894), page 237.

Potassium alum — $K_2SO_4,Al_2(SO_4)_3,24H_2O$. — This product is known also as "potash alum" and "common alum." The manufacture of alum from bauxite involves the preparation of a pure solution of aluminum sulphate to which is added the proper proportion of an alkali sulphate in order to form the special alum desired. Thus potassium sulphate is used to form potassium alum and sodium sulphate for sodium alum. All alums crystallize from solutions perfectly, forming very pure crystals even from impure solutions, and it is because of this property that the alums are so extensively used in the arts. The chief uses of common alum are as a mordant in dyeing; in preparing size in paper making; in tawing skins; in making pigment lakes; for clarifying turbid liquors; for precipitating sewage waters; and for hardening plaster of Paris casts and other forms. For these uses, however, as mentioned above, aluminum sulphate is generally preferred because of its greater strength and solubility.

Aluminum hydroxide—$Al_2(OH)_6$.—The manufacture of aluminum hydroxide from bauxite is of great importance, because by a simple calcination it yields aluminum oxide (alumina), which is the chief crude material used for the manufacture of the metal aluminum. In making aluminum hydroxide, bauxite is roasted, pulverized, and mixed with calcined soda ash in the proportion of 1 part of Al_2O_3 to 1.1 parts of Na_2O, or greater if silica be present in the ore. The mixture is calcined at a white heat for three or four hours until all traces of carbon dioxide and water have been expelled. The calcined product is then ground and lixiviated with hot water; this process yields a solution of sodium aluminate from which the aluminum hydroxide is precipitated by passing carbon dioxide gas through it. The impurities, silica and iron oxide, remain dissolved in the mother liquor.

In order to avoid the costly and tedious chemical process of obtaining pure aluminum hydroxide, an electric furnace method has been recently patented by Mr. Charles M. Hall,[1] whereby the impurities in the bauxite, mainly iron oxide and silica, are removed, and the bauxite is thus purified for the aluminum reduction process. The process of purifying the bauxite consists in submitting it to a preliminary heating for some hours in the presence of carbon and metallic aluminum in an electric furnace, during which time the iron oxide and the silica become reduced to metallic iron and silicon and combine with the aluminum to form a heavy alloy, which can be detached easily from the mass of purified bauxite after it has cooled.

Artificial emery.—Within the past year or so a company at Niagara Falls, N. Y., has consumed a considerable quantity of bauxite for the manufacture of abrasive wheels.

TABLE 4.—*Detailed summary: 1902.*

Number of mines or quarries	38
Number of operators	[1]7
Character of ownership	
Individual	2
Incorporated company	5
Salaried officials, clerks, etc..	
Total number	42
Total salaries	$33,230
General officers—	
Number	5
Salaries	$10,000
Superintendents, managers, foremen, surveyors, etc.—	
Number	32
Salaries	$19,630
Clerks—	
Number	5
Salaries	$3,600
Wage-earners:	
Total average number above ground	150
Total wages	$56,763
Engineers, firemen, and other mechanics—	
Average number	17
Wages	$10,050
Miners or quarrymen—	
Average number	77
Wages	$21,269
Boys under 16 years—	
Average number	3
Wages	$450
All other wage earners—	
Average number	53
Wages	$24,994
Average number of wage-earners at specified daily rates of pay:	
Engineers—	
$1.00 to $1.24	1
$1.25 to $1.49	5
$1.50 to $1.74	1
$2.00 to $2.24	1
$2.50 to $2.74	1
Firemen—	
$1.00 to $1.24	1
$1.50 to $1.74	1
$2.50 to $2.74	1
Machinists, blacksmiths, carpenters, and other mechanics—	
$2.50 to $2.74	3
$2.75 to $2.99	2
Miners or quarrymen—	
$0.75 to $0.99	5
$1.00 to $1.24	64
$1.25 to $1.49	8
Boys under 16 years—	
Less than $0.50	1
$0.50 to $0.74	2
All other wage earners—	
$1.00 to $1.24	3
$1.25 to $1.49	10
$1.50 to $1.74	40
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	145
February	147
March	147
April	157
May	161
June	147
July	143
August	143
September	145
October	160
November	146
December	138
Boys under 16 years—	
January	2
February	2
March	3
April	3
May	4
June	4
July	4
August	4
September	3
October	3
November	2
December	2
Contract work	
Amount paid	$500
Number of employees	10
Miscellaneous expenses	
Total	$14,939
Royalties and rent of mine and mining plant	$2,090
Rent of offices, taxes, insurance, interest, and other sundries	$12,849
Cost of supplies and materials	$30,019
Product	
Quantity, long tons	29,222
Value	$128,206
Power owned:	
Total horsepower	624
Engines—	
Steam—	
Number	19
Horsepower	575
Gas or gasoline—	
Number	2
Horsepower	49
Electric motors—	
Number	4
Horsepower	64

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[1] United States patents Nos. 677,207, 677,208 (July, 1901), and No. 706,553 (August, 1902).

[1] Includes operators distributed as follows: Alabama, 1 (3 mines); Arkansas, 3 (19 mines); Georgia, 3 (16 mines).

FLINT AND FELDSPAR

FLINT AND FELDSPAR.

By Story B. Ladd.

The chief consumption of both flint (or quartz) and feldspar is in the pottery industry, and as the mining of these minerals is in some cases associated, the general statistics of the two industries are presented together, as well as separately.

Table 1 is a combined summary of the statistics for the flint and feldspar industries for 1902.

TABLE 1.—*Summary: 1902.*

Number of mines or quarries	46
Number of operators	[illegible]
Salaried officials, clerks, etc.	
Number	[illegible]
Salaries	[illegible]
Wage earners	
Average number	[illegible]
Wages	[illegible]
Miscellaneous expenses	[illegible]
Cost of supplies and materials	[illegible]
Product	
Quantity, short tons	[illegible]
Value	[illegible]
Flint	
Quantity, short tons	[illegible]
Value	[illegible]
Feldspar	
Quantity, short tons	45,287
Value	$250,424

Of the 46 mines, 18 produced flint, 23 feldspar, and 5 both flint and feldspar. Of these 5 mines, 4 were in Maine and 1 in Massachusetts. Feldspar was the chief product of the 4 mines in Maine, which also produced 1,254 short tons of flint, valued at $2,593, as a by-product; and flint was the chief product of the 1 mine in Massachusetts, with 112 short tons of feldspar, valued at $1,000, as a by-product. One corporation operated a feldspar and flint mine in Maine and a flint mine in Pennsylvania; 1 corporation operated a feldspar and flint mine in Maine and a flint mine in Maryland; and 1 corporation operated feldspar mines in Pennsylvania and Maryland.

The details of the capital stock of 9 of the 11 incorporated companies are shown in the following table:

TABLE 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	[1]11
Number reporting capitalization	[2]9
Capital stock	
Total authorized—	
Number of shares	106,910
Par value	$631,000
Total issued—	
Number of shares	46,103
Par value	$493,400
Dividends paid	$58,800
Common—	
Authorized—	
Number of shares	106,710
Par value	$621,000
Issued—	
Number of shares	45,903
Par value	$483,400
Dividends paid	$58,800
Preferred—	
Authorized—	
Number of shares	200
Par value	$10,000
Issued—	
Number of shares	200
Par value	$10,000
Assessments levied	[illegible]

One of these 11 companies, mining feldspar in Pennsylvania, was not engaged chiefly in mining or quarrying, and its capitalization was not reported. Also 1 of the companies mining feldspar and flint in Maine was a large clay producer in Delaware, and its capitalization appears under the clay statistics. Both flint and feldspar were produced by 2 of the companies in Maine and 1 in Massachusetts; 6 of the companies mined feldspar only, and 2 mined flint only.

FLINT.

The statistics for flint or quartz presented herewith do not include those for crystalline quartz, which is used principally as an abrasive, or as a wood finisher, and which is separately considered in the class of abrasive materials.

The flint or quartz production of the United States in 1902, that is, the flint mined or quarried as such, with the exception above noted, amounted to 36,365 short tons, valued at $144,209. In 1889 the production of flint was 11,113 long tons, or 12,448 short tons, valued at $49,137. At the census of 1880 the production of "quartz and feldspar" was reported as 21,571 long tons, valued at $103,878.

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[1] Includes companies distributed as follows: Connecticut, 2; Maine, 3; Maryland, 2; Massachusetts, 1; Pennsylvania, 3.

[2] Includes companies distributed as follows: Connecticut, 2; Maine, 2; Maryland, 2; Massachusetts, 1; Pennsylvania, 2.

The crystalline quartz production for the year 1902 was 15,104 short tons, valued at $43,085, which, added to the flint production, makes a total of 51,469 tons, valued at $187,294, for the combined production of flint and crystalline quartz for 1902. The production of quartz as a whole has therefore increased from 12,448 short tons in 1889, to 51,469 short tons in 1902, or over 300 per cent; and the value from $49,137 to $187,294, or over 280 per cent. The average price in 1889 was $3.95 per short ton; and in 1902, the average price for the entire quartz production, flint and crystalline quartz combined, was $3.64 per short ton.

There were 19 active flint mines or quarries located—4 in Connecticut, 6 in Maryland, 4 in Pennsylvania, 2 in New York, and 1 each in Massachusetts, Montana, and Virginia. These were controlled by 17 operators—10 individuals, 4 firms, and 3 incorporated companies.

There were 6 operators who reported no flint mined during the year—3 individual operators in Connecticut, 1 individual operator in Maryland, 1 individual operator in New York, and 1 incorporated company in Wisconsin, which was engaged chiefly in the production of clay, but in former years had produced a small amount of flint as a by-product.

Employees and wages.—The wage-earners constituted 86.9 per cent of the salaried employees and wage-earners, and their wages were 76.8 per cent of the total salaries and wages.

The average number of wage-earners employed during each month is shown in Table 5. The least number was employed during the winter months and the largest number during the summer months, though the range was not large, the minimum being 91 in December and the maximum 138 in July.

The average number of wage-earners employed at specified daily rates of pay is also shown in Table 5. The mines that produced flint or quartz as such, with the exception of the mine in Montana, were located in the Atlantic coast states and the product is chiefly used by the pottery industry, which is chiefly confined to the states east of the Mississippi. Of the wage-earners 71 per cent received less than $1.50 per day, 22 per cent $1.50 to $1.99 per day, and but 8 per cent $2 and over. Of the 65 miners or quarrymen 58 received from $1 to $1.74 per day, and only 7 received $1.75 and over. Of the latter, 4, at $3 to $3.24, were in Montana.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials was reported as $18,642, and the miscellaneous expenses as $14,291. Of the latter, the sum of $5,813 was paid by 11 mines for royalties and rent of mine and mining plant, these mines being located, 2 in Connecticut, 3 in Maryland, 4 in Pennsylvania, and 1 each in New York and Virginia; and the sum of $8,478 by 17 mines for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—Of the 23 mines or quarries, 8 employed power aggregating 740 horsepower, of which 155 horsepower was furnished by 4 steam engines, and 585 horsepower by 10 water wheels. The waterpower was reported for 5 mines in Maryland and 1 mine in Massachusetts.

Production.—The total production for the year 1902 was 36,365 short tons, valued at $144,209. This consisted of 20,295 tons of crude flint, valued at $35,046, an average of $1.73 per ton, and 16,070 tons of ground flint, valued at $109,163, an average of $6.79 per ton. Montana was the largest producer in quantity, with 10,640 short tons of crude flint, valued at $14,250. The production of Maryland and Pennsylvania was approximately the same, each 26.9 per cent of the total, but Maryland produced 49.2 per cent of the ground flint, and Pennsylvania 34.5 per cent. The United States Geological Survey has published annual statistics showing the quantity and value of flint produced since 1892, and in the following table there is shown the total production and value for each year:

TABLE 3.—*Production of flint: 1892 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (short tons).	Value.
1892	22,400	$89,600
1893	33,253	66,792
1894	42,560	319,200
1895	13,747	21,068
1896	12,458	24,226
1897	13,496	26,227
1898	21,625	42,670
1899	29,852	180,345
1900	32,495	89,351
1901	34,420	149,297
1902	36,365	144,209

The average price of flint per ton is so variable, ranging from a minimum of $1.53 in 1895 to a maximum of $7.50 in 1894, that no comparison can be made as to values. The largest production was in 1894, when it reached 42,560 short tons, and the smallest was 12,458 short tons in 1896. Since 1896, the production shows a steady increase year by year. The average price of crude flint in 1900, 1901, and 1902 was practically stationary, varying only from $1.73 to $1.86 per ton, while the average price of ground flint increased from $3.73 per ton in 1900 to $6.72 per ton in 1901, and $6.79 per ton in 1902.

The value of the imports for consumption of flint and flint stones, unground, for the fiscal years ending June 30, 1900, 1901, and 1902, respectively, were $40,475, $64,697, and $85,092. The imports were chiefly from France, Denmark, and Belgium, in the order named, with more than half the values coming from France, and a small amount from Germany.

A detailed summary of the statistics for flint is given in Table 5.

Occurrence and use.—Although silica or quartz is widely distributed in igneous and metamorphic rocks, and constitutes the gangue of many metalliferous veins, yet it is only the pure non-ore bearing quartz veins that are chiefly drawn upon for the quartz production of the United States. Many quartzites or sandstones are of sufficient purity to be ground for potters' use.

The term flint, as properly used, refers to the cryptocrystalline variety of silica occurring in nodular masses in calcareous strata, particularly in chalk. This is found in the United States in Texas and Arkansas and Florida, but is not at present utilized. The mineral worked throughout the entire Appalachian region, either for pottery or under the name of "flint," and included in this report, is quartz. The imported flint, on the other hand, is in part, if not wholly, the true flint from the chalk cliffs.

Flints when calcined and ground to powder enter into the composition of many kinds of fine pottery and were formerly employed in the manufacture of the finer varieties of glass, hence termed "flint glass."

The manufacture of gunflints was formerly an important industry, and the use of flints in the "stone age" and the later periods for the manufacture of axes, knives, spearheads, arrowheads, and the like, forms one of the most interesting fields of research for the antiquary and archaeologist.

The flint product, like feldspar, is used chiefly in the pottery and porcelain industry, though some is consumed in the manufacture of scouring soaps and wood fillers.

FELDSPAR.

The feldspar product of the United States for the year 1902 amounted to 45,287 short tons, of a value of $250,424. In 1880 the production was included in "quartz and feldspar," cited under "Flint" in this report. The only statistics pertaining to the feldspar production reported at the Eleventh Census, for the year 1889, with which comparison can be made are the quantity produced and its value. The production was 6,970 long tons, or 7,806 short tons, valued at $39,870. The average prices for all material, crude and ground, for the census years 1889 and 1902, were $5.04 and $5.53 per short ton, respectively. There has been a very considerable increase in the production during the last decade, with slight increase in average value.

As shown by Table 6, Pennsylvania had the largest number of feldspar mines or quarries, 12 in number, and produced one-third of the entire feldspar product and approximately one-half of the ground feldspar.

There were 9 idle mines in 1902. Of the operators, 7 were individuals, 4 in Pennsylvania and 1 each in Alabama, Connecticut, and New York; 1 was an incorporated company in New York, and 1 a firm (limited partnership) in Connecticut. The capital stock of the incorporated company was 200,000 shares, all common stock, of a par value of $200,000, authorized; of which 150,000 shares, of a par value of $150,000, had been issued. The power of the idle establishments aggregated 42 horsepower, reported by 1 operator in Connecticut and 1 in New York.

Employees and wages.—The wage-earners constituted 90.8 per cent of the salaried employees and wage-earners, and their wages were 84.2 per cent of the total salaries and wages. The average number of wage-earners employed by months is shown in Table 6. The maximum number, 279, appears in July, and the minimum, 227, in February, with an average of 252. Boys under 16 years of age were employed in two cases: 1 mine in Pennsylvania employed an average of 2 for the year, and 1 mine in Maryland an average of 1.

The average number of wage-earners employed at specified daily rates of pay is also shown in Table 6. The mines producing feldspar were all located in the Atlantic coast states, and, moreover, were all surface mines, no underground working being reported; hence the wages paid were comparatively low. Of the wage-earners, 61 per cent received less than $1.50 per day; 32 per cent from $1.50 to $1.74, and but 7 per cent $1.75 and over. Of the 183 miners or quarrymen, who constituted 73 per cent of all wage-earners, 69 per cent received not to exceed $1.49 per day and 30 per cent from $1.50 to $1.74; only 3 miners received $1.75 or more.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials was $50,278, and the miscellaneous expenses, $19,407. Of the latter the sum of $10,584 was paid by 14 mines for royalties and rent of mine and mining plant, these mines being located—4 in Connecticut, 2 in Maine, 2 in Maryland, and 6 in Pennsylvania; and $8,823 by 19 mines for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—Of the 27 mines or quarries, 13 employed power aggregating 1,204 horsepower, of which 854 horsepower was furnished by 15 steam engines and 350 horsepower by 7 water wheels. The waterpower was reported for 2 mines in Connecticut, 1 in Maine, and 1 in Pennsylvania.

Production.—The total production for 1902 was 45,287 short tons, valued at $250,424. This consisted of 21,870 short tons of crude feldspar, valued at $55,501, an average of $2.54 per ton, and 23,417 short tons of ground or prepared feldspar, valued at $194,923, an average of $8.32 per ton.

Of the several producing states Pennsylvania reported the largest amount, constituting 33 per cent of the total quantity, 29 per cent of the total crude product, and 37 per cent of the total ground product. Connecticut was the next in rank, producing 31 per cent of the total quantity, 24 per cent of the total crude product, and 37 per cent of the total ground product. Maine produced 19 per cent of the total product, 21 per cent of the total crude product, and 16 per cent of the total ground product.

The United States Geological Survey has published annual statistics of the quantity and value of feldspar produced since 1892, and they are shown in Table 4.

TABLE 4.—*Production of feldspar: 1892 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (short tons).	Value.
1892	16,800	$75,000
1893	20,578	68,307
1894	19,264	167,000
1895	8,523	30,000
1896	10,203	55,200
1897	12,516	43,100
1898	13,440	32,395
1899	24,202	211,545
1900	24,821	180,971
1901	34,741	220,422
1902	45,287	250,424

For the years 1892 to 1899, inclusive, the production of the combined product of crude and ground feldspar and the average price per ton was so variable, ranging from a minimum of $2.41 per short ton for 1898 to a maximum of $8.74 per short ton in 1899, that no comparisons can be made as to values. In 1893 the production aggregated 20,578 short tons, succeeded by a drop to 8,523 short tons in 1895. Since 1895 there has been an increase, year by year, of the total quantities. The average price of crude feldspar per ton was $4.06 in 1900, $2.18 in 1901, and $2.54 in 1902. The price of ground feldspar per ton shows a slight increase, advancing from $7.54 in 1900 to $8.01 in 1901 and $8.32 in 1902.

There was some importation of feldspar from Canada, but not being separately returned to the Treasury Department the statistics can not be given.

A detailed summary of the statistics for feldspar is given in Table 6.

Occurrence and use.—The members of the group of feldspar, or feldspars, are anhydrous double silicates, consisting of a silicate of alumina combined with a silicate of potash, soda, or lime, or with two or all of these. In all the members of the group there exists the simple relation of one atom of the sesquioxide, alumina, to one of the protoxide base or bases, but the proportion of silica varies considerably in the different species. The highly silicated species, as orthoclase, albite, and oligoclase, occur in granite, trachytes, and other so-called acid rocks, while the less silicated feldspars, as labradorite, are confined to basalts and other basic rocks.

Orthoclase is the most ordinary species, and is the one most commonly used in this country. It is a potash feldspar, of which a typical analysis from Bedford, N. Y., is: Silica, 64.97; alumina, 20.85; alkalies, 13.72; and water, 0.46=100.

Labradorite is a soda-lime feldspar, consisting of silica, 55.75; alumina, 26.50; lime, 11; soda, 4; peroxide of iron, 1.25; water, 0.50=99.

The feldspars fuse, when exposed to a high temperature, to a vitreous enamel possessing considerable hardness, a property which has led to their use in glazing pottery. The chief consumption of feldspar is in the manufacture of pottery and tiles, although it is also used in the manufacture of wood fillers, scouring soaps, and in glass manufacture.

TABLE 5.—*Flint, detailed summary: 1902.*

	United States.	Connecticut.	Maryland.	Pennsylvania.	All other states.[1]
Number of mines or quarries	19	4	[2]6	[2]4	5
Number of operators	17	4	5	3	5
Character of ownership:					
Individual	10	3	1	3	3
Firm	4	1	2		1
Incorporated company	3		2		1
Salaried officials, clerks, etc.:					
Total number	18	2	14	1	1
Total salaries	$14,330	$1,200	$11,080	$1,500	$550
General officers—					
Number	3		3		
Salaries	$3,875		$3,875		
Superintendents, managers, foremen, surveyors, etc.—					
Number	10	1	7	1	1
Salaries	$9,105	$900	$6,155	$1,500	$550
Clerks—					
Number	5	1	4		
Salaries	$1,350	$300	$1,050		
Wage-earners.					
Above ground—					
Total average number	119	10	65	27	17
Total wages	$47,454	$4,815	$21,403	$11,713	$9,523
Engineers, firemen, and other mechanics—					
Average number	11	1	7	2	1
Wages	$5,187	$737	$3,037	$1,248	$165
Miners or quarrymen—					
Average number	65	8	26	16	15
Wages	$27,648	$3,903	$8,352	$6,875	$8,518
All other wage-earners—					
Average number	43	1	32	9	1
Wages	$14,619	$175	$10,014	$3,590	$840
Average number of wage-earners at specified daily rates of pay:					
Engineers—					
$1.50 to $1.74	2		2		
$2.00 to $2.24	2			2	
$2.50 to $2.74	1	1			
Firemen—					
$1.50 to $1.74	2		2		
Machinists, blacksmiths, carpenters, and other mechanics—					
$1.50 to $1.74	3		3		
$2.00 to $2.24	1				1
Miners or quarrymen—					
$1.00 to $1.24	23		23		
$1.25 to $1.49	20		2	16	2
$1.50 to $1.74	15	8			7
$1.75 to $1.99	2				2
$2.00 to $2.24	1		1		
$3.00 to $3.24	4				4
All other wage-earners—					
$0.50 to $0.74	1		1		
$1.00 to $1.24	31		31		
$1.25 to $1.49	9			9	
$1.50 to $1.74	2	1			1
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	99	4	61	23	11
February	95	5	61	23	6
March	103	5	63	28	7
April	119	9	67	28	15
May	131	13	67	30	21
June	137	17	67	30	23
July	138	15	69	32	22
August	134	16	69	28	21
September	134	11	69	28	26
October	127	9	68	28	22
November	120	8	69	23	20
December	91	8	50	23	10
Miscellaneous expenses:					
Total	$14,291	$675	$9,572	$3,137	$907
Royalties and rent of mine and mining plant	$5,813	$520	$3,087	$2,074	$132
Rent of offices, taxes, insurance, interest, and other sundries	$8,478	$155	$6,485	$1,063	$775
Cost of supplies and materials	$18,642	$1,965	$8,627	$4,425	$3,625
Product:					
Quantity, short tons	36,365	1,812	9,798	9,785	14,970
Value	$144,209	$11,575	$56,551	$42,721	$33,362
Crude—					
Quantity, short tons	20,295	852	1,895	4,238	13,310
Value	$35,046	$1,775	$5,300	$7,721	$20,250
Ground—					
Quantity, short tons	16,070	960	7,903	5,547	1,660
Value	$109,163	$9,800	$51,251	$35,000	$13,112
Power owned:					
Total horsepower	740	15	525	40	160
Engines—					
Steam—					
Number	4	1	1	2	
Horsepower	155	15	100	40	
Water wheels—					
Number	10		8		2
Horsepower	585		425		160

[1] Includes operators distributed as follows: Massachusetts, 1; Montana, 1; New York, 2; Virginia, 1.

[2] The additional mine was operated by one of the operators mining feldspar and flint in Maine.

TABLE 6.—FELDSPAR, DETAILED SUMMARY: 1902.

	United States.	Connecticut.	Maine.	Pennsylvania.	All other states.[1]
Number of mines or quarries	27	6	5	12	4
Number of operators	26	6	5	12	3
Character of ownership:					
Individual	15	4	2	9	....
Firm	3	....	....	....	3
Incorporated company	8	2	3	[2]3	....
Salaried officials, clerks, etc.:					
Total number	27	8	6	9	4
Total salaries	$20,095	$5,345	$4,713	$8,712	$1,325
General officers—					
Number	4	....	2	2	....
Salaries	$4,275	....	$775	$3,500	....
Superintendents, managers, foremen, surveyors, etc.—					
Number	20	7	4	6	3
Salaries	$14,800	$4,745	$3,938	$5,092	$1,025
Clerks—					
Number	3	1	....	1	1
Salaries	$1,020	$600	....	$120	$300
Wage-earners:					
Above ground—					
Total average number	252	71	40	125	16
Total wages	$107,444	$33,672	$16,414	$50,876	$6,482
Engineers, firemen, and other mechanics—					
Average number	18	7	4	6	1
Wages	$8,954	$3,505	$1,871	$3,128	$450
Miners or quarrymen—					
Average number	183	38	27	104	14
Wages	$77,541	$17,869	$10,871	$42,881	$5,920
Boys under 16 years—					
Average number	3	....	....	2	1
Wages	$532	....	....	$420	$112
All other wage-earners—					
Average number	48	26	9	13	....
Wages	$20,417	$12,298	$3,672	$4,447	....
Average number of wage-earners at specified daily rates of pay:					
Engineers—					
$1.25 to $1.49	1	....	....	1	....
$1.50 to $1.74	5	2	2	....	1
$1.75 to $1.99	2	2	....	....	....
$2.00 to $2.24	2	1	....	1	....
$2.50 to $2.74	1	....	....	1	....
Firemen—					
$2.00 to $2.24	1	....	1	....	....
Machinists, blacksmiths, carpenters, and other mechanics—					
$1.50 to $1.74	1	1	....	....	....
$1.75 to $1.99	3	1	....	2	....
$2.00 to $2.24	2	....	1	1	....
Miners or quarrymen—					
$1.00 to $1.24	1	....	....	....	1
$1.25 to $1.49	125	....	16	102	7
$1.50 to $1.74	54	37	10	1	6
$1.75 to $1.99	1	....	1	....	....
$2.50 to $2.74	2	1	....	1	....
Boys under 16 years—					
$0.75 to $0.99	3	....	....	2	1
All other wage-earners—					
$1.00 to $1.24	1	....	....	1	....
$1.25 to $1.49	23	4	8	11	....
Average number of wage-earners at specified daily rates of pay—Cont'd.					
All other wage-earners—Cont'd.					
$1.50 to $1.74	21	21	....	....	....
$1.75 to $1.99	2	1	....	1	....
$2.00 to $2.24	1	....	1	....	....
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	226	71	25	123	7
February	225	70	26	122	7
March	229	72	28	118	11
April	248	68	41	119	20
May	249	68	36	125	20
June	226	70	19	117	20
July	276	71	61	125	19
August	259	70	57	116	16
September	272	77	48	132	15
October	252	71	42	124	15
November	251	72	39	129	11
December	242	72	31	126	13
Boys under 16 years—					
January	2	....	....	2	....
February	2	....	....	2	....
March	2	....	....	2	....
April	3	....	....	2	1
May	3	....	....	2	1
June	3	....	....	2	1
July	3	....	....	2	1
August	3	....	....	2	1
September	3	....	....	2	1
October	4	....	....	2	2
November	4	....	....	2	2
December	4	....	....	2	2
Miscellaneous expenses:					
Total	$19,407	$4,564	$3,983	$9,074	$1,786
Royalties and rent of mine and mining plant	$10,584	$3,854	$812	$4,818	$1,100
Rent of offices, taxes, insurance, interest, and other sundries	$8,823	$710	$3,171	$4,256	$686
Cost of supplies and materials	$50,278	$10,677	$5,388	$32,423	$1,790
Product:					
Quantity, short tons	45,287	13,949	8,495	15,121	7,722
Value	$250,424	$73,764	$38,711	$115,699	$22,250
Crude—					
Quantity, short tons	21,870	5,207	4,665	6,388	5,610
Value	$55,501	$14,122	$12,206	$19,923	$9,250
Ground—					
Quantity, short tons	23,417	8,742	3,830	8,733	2,112
Value	$194,923	$59,642	$26,505	$95,776	$13,000
Power owned:					
Total horsepower	1,204	577	150	427	50
Engines—					
Steam—					
Number	15	6	3	5	1
Horsepower	854	407	70	327	50
Water wheels—					
Number	7	3	2	2	....
Horsepower	350	170	80	100	....

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[1] Includes operators distributed as follows: Maryland, 2; New York, 1.

[2] One company operated 2 mines, 1 each in Pennsylvania and Maryland.

FULLER'S EARTH

FULLER'S EARTH.

By Story B. Ladd.

Fuller's earth was first discovered in the United States at Quincy, Fla., in 1893, and the production is now for the first time reported at a United States census. Table 1 is a summary of the statistics for the year 1902.

Table 1.—*Summary: 1902.*

Number of mines	4
Number of operators	4
Salaried officials, clerks, etc.:	
Number	15
Salaries	$10,040
Wage-earners:	
Average number	114
Wages	$31,77[illegible]
Contract work	$4,021
Miscellaneous expenses	$2,057
Cost of supplies and materials	$28,966
Product:	
Quantity, short tons	11,492
Value	$98,144

There were only 4 mines in operation, 2 each in Arkansas and Florida, the latter state producing 90.4 per cent of the total quantity. The production for 1902 was 11,492 short tons, valued at $98,144, or an average of $8.54 per ton, the minimum being $8 and the maximum $13.33. The 4 mines were controlled by 1 individual operator and 3 incorporated companies. There were 2 idle mines in 1902—1 in Georgia and 1 in New York.

Capital stock of incorporated companies.—The following table presents the details of the capitalization of the incorporated companies:

Table 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	[1]3
Number reporting capitalization	[2]2
Capital stock:	
Total authorized—	
Number of shares	3,200
Par value	$230,000
Total issued—	
Number of shares	3,200
Par value	$230,000
Common—	
Authorized—	
Number of shares	2,200
Par value	$130,000
Issued—	
Number of shares	2,200
Par value	$130,000
Preferred—	
Authorized—	
Number of shares	1,000
Par value	$100,000
Issued—	
Number of shares	1,000
Par value	$100,000

All of the stock authorized—3,200 shares, having a par value of $230,000—has been issued. No dividends were reported.

Employees and wages.—The average number of wage-earners employed during each month, and their specified daily rates of pay according to occupations, are shown in Table 4. The large increase in the number of men employed for the last four months of the year was due to the beginning of operations by a new producer. Eliminating the men employed by this new operator, it appears that the busiest month was January, while the industry was at its lowest ebb in July.

As the excavation of fuller's earth requires no skill, the rates of pay should not be compared with those in mining industries requiring skill and experience. The rates for miners are only those ordinarily received by unskilled day laborers. Of the 54 miners employed, 81.5 per cent received less than $1.25 per day, and the remaining 18.5 per cent from $1.25 to $1.99 per day. Eight employees were engaged in contract work, for which $4,021 was expended.

Supplies, materials, and miscellaneous expenses.—The cost of supplies and materials was $28,966; the miscellaneous expenses amounted to $2,057, all for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power.—For the 4 mines 460 horsepower was reported, supplied by 7 steam engines with a capacity of 430 horsepower, and 2 gas or gasoline engines with a capacity of 30 horsepower. All of the gas or gasoline power and 80 per cent of the steam power were reported from Florida.

Production.—The production for the year 1902 was 11,492 short tons, valued at $98,144. The United States Geological Survey has published annual statistics showing the quantity and value of fuller's earth produced. In the following table these, together with the statistics of imports of both the crude and manufactured article, with the average value per ton, are shown from 1898 to 1902. Quantities are shown in short tons for purposes of comparison.

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[1] Includes 1 company in Arkansas and 2 in Florida.
[2] Includes 1 company in Arkansas and 1 in Florida.

TABLE 3.—PRODUCTION AND IMPORTS OF FULLER'S EARTH: 1898 TO 1902.

YEAR.	PRODUCTION.			IMPORTS.[1]								
				Total.			Crude.			Wrought or manufactured.		
	Quantity (short tons).	Value.	Average value per ton.	Quantity (short tons).	Value.	Average value per ton.	Quantity (short tons).	Value.	Average value per ton.	Quantity (short tons).	Value.	Average value per ton.
1898	14,860	$106,500	$7.17	9,356	$71,044	$7.59	2,283	$15,921	$6.97	7,073	$55,123	$7.79
1899	12,381	79,644	6.43	11,558	69,640	6.03	4,192	23,194	5.53	7,366	46,446	6.31
1900	9,698	67,535	6.96	9,154	64,797	7.08	2,723	14,750	5.42	6,431	50,047	7.78
1901	14,112	96,835	6.86	12,061	80,697	6.69	3,268	17,230	5.27	8,793	63,467	7.22
1902	11,492	98,144	8.54	15,134	102,580	6.78	4,239	26,635	6.28	10,895	75,945	6.97

[1] Quantities have been converted into short tons for purposes of comparison.

For each year except 1902 the domestic production slightly exceeded the imports, the percentage of the total consumption — production and imports — which was produced in the United States being 61 in 1898, 52 in 1899, 51 in 1900, 54 in 1901, and 43 in 1902.

During the period from 1897 to 1902 the average value of imports per short ton ranged from a minimum of $6.03 in 1899 to a maximum of $7.59 in 1898; the average value of fuller's earth imported in a crude state—unwrought or unmanufactured—ranged from a minimum of $5.27 in 1901 to a maximum of $6.97 in 1898, while the average value of the wrought or manufactured earth imported ranged from a minimum of $6.31 in 1899 to a maximum of $8.37 in 1897. During the period from 1867 to 1883 the average value per short ton of imports of fuller's earth, based upon the custom house returns to the Treasury Department, ranged from a minimum of $9.77 in 1870 to a maximum of $11.25 in 1882, with an average of $10.59 for the entire period.

Table 4 is a detailed summary for the industry in 1902.

DESCRIPTIVE.

Fuller's earth derives its name from having been used in fulling cloth and wool and cleansing them of grease; it was also used by furriers for cleansing furs. It is a variety of clay resembling other clays in appearance, but commonly lacking plasticity. It is fine grained, of variable color, of a specific gravity of from 1.8 to 2.2, and has strong absorbent properties.

The composition of fuller's earth varies considerably, but this variation may be due in part to impurities. As a rule there is a high percentage of combined water; this is most marked in the case of the foreign product. The following analyses show the composition of samples, both domestic and foreign:

Analyses of fuller's earth.[1]

CONSTITUENT	Gadsden county, Fla.	Decatur county, Ga.	Reigate, England	Enid, Okla.	Fairburn, S. Dak.	Sumter, S. C.
Silica	62.83	67.46	58.00	50.36	58.72	74.25
Alumina	10.35	10.08	10.00	33.38	16.90	10.10
Ferric oxide	2.45	2.49	9.75	3.31	1.00	1.80
Lime	2.43	3.14	0.50		1.06	1.90
Magnesia	3.12	1.09	1.25		2.96	2.10
Soda	0.20				2.11	1.60
Potash	0.74					
Water	7.72	5.61	24.10	15.00	8.10	5.70
Moisture	6.41	6.41			2.50	2.50

A variety of fuller's earth occurring in the island of Argentiera, Greece, has been mined since ancient times. In England there is an argillaceous deposit 150 feet thick, extending from Dorsetshire to Bath and Cheltenham. Fuller's earth is mined especially near Reigate, in Surrey, and at one time was considered of such importance that its exportation was prohibited under severe penalties.

The discovery of fuller's earth in Florida in 1893 caused much excitement, and a search was made for other deposits. The deposit at Quincy, Gadsden county, in that state, extending through Leon county and into Decatur county, Ga., still ranks first in commercial importance. But beds, varying widely in character, have been found in Hillsboro, Manatee, and Marion counties, Fla.; Columbia county, Ga.; Sumter county, S. C.; Oneida county, N. Y.; Saline county, Ark.; Garfield county, Okla.; Custer county, S. Dak.; Cherry county, Nebr.; Fremont county, Colo.; Kern county, Cal.; and in Utah. The Florida and Georgia deposits, which are very similar, do not resemble the English product. The fuller's earth of South Dakota, however, is almost identical with the English earth, and mines in that state will probably in time become important producers.

The methods of mining fuller's earth and preparing it for the market are very simple. The overburden of sand and worthless plastic clay is removed, and the wet fuller's earth is chopped out in thin slices with mattocks and dried in the sun. The wet, greenish clay loses perhaps half of its weight, changes to a creamy white color, and becomes very brittle, easily splitting into thin layers. Artificial driers and an arrangement for grinding the earth to the requisite degree of fineness have been recently introduced.

The Florida earth, ground to 60 mesh or finer, is used almost entirely as a substitute for boneblack in filtering mineral lubricating oils. The common practice is to run the earth into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. The oil which comes out first is water white in color and much thinner than that which follows.

While the Florida earth is superior to the English variety for the refining of mineral oils, the English product is much more desirable for the treatment of animal and vegetable oils. The process is radically different. The oil is heated in large tanks to a temperature above the boiling point of water, and from 5 to 10 per cent of its weight of fuller's earth, ground to 120 mesh, is added; the mixture is stirred vigorously for twenty minutes and then filtered off through bag filters.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1901, pages 93 and 161.

Perhaps the most remarkable feature of filtration by the use of fuller's earth is the fact that—even in the mixture of oils present in crude petroleum—the oil which first percolates through the earth is the lowest in specific gravity. Indeed, the separation which can be secured by this process is comparable with the results of fractional distillation.

TABLE 4.—*Detailed summary: 1902.*

Number of mines	4
Number of operators	[1] 4
Character of ownership:	
Individual	1
Incorporated company	3
Salaried officials, clerks, etc:	
Total number	14
Total salaries	$10,000
General officers—	
Number	2
Salaries	$3,500
Superintendents, managers, foremen, surveyors, etc.—	
Number	9
Salaries	$5,000
Clerks—	
Number	3
Salaries	$1,500
Wage-earners:	
Total average number (above ground)	114
Total wages	$33,775
Engineers, firemen, and other mechanics—	
Average number	12
Wages	$6,335
Miners—	
Average number	54
Wages	$17,140
Boys under 16 years—	
Average number	24
Wages	$3,725
All other wage-earners—	
Average number	24
Wages	$6,575
Average number of wage-earners at specified daily rates of pay:	
Engineers—	
$1.50 to $1.74	1
$2.00 to $2.24	2
$3.00 to $3.24	1
Average number of wage-earners at specified daily rates of pay—Continued.	
Firemen—	
$1.00 to $1.24	3
$1.50 to $1.74	2
Machinists, blacksmiths, carpenters, and other mechanics—	
$1.50 to $1.74	3
Miners—	
$0.75 to $0.99	15
$1.00 to $1.24	29
$1.25 to $1.49	2
$1.50 to $1.74	5
$1.75 to $1.99	3
Boys under 16 years—	
$0.75 to $0.99	24
All other wage-earners—	
$0.75 to $0.99	15
$1.00 to $1.24	5
$1.25 to $1.49	4
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	68
February	63
March	60
April	66
May	66
June	55
July	48
August	60
September	130
October	158
November	148
December	138
Boys under 16 years—	
January	24
February	24
March	24
April	24
May	24
June	24
July	24
August	24
September	24
October	24
November	24
December	24
Contract work:	
Amount paid	$4,021
Number of employees	8
Miscellaneous expenses (rent of offices, taxes, insurance, interest, and other sundries)	$2,057
Cost of supplies and materials	$28,966
Product:	
Quantity, short tons	11,492
Value	$98,144
Power owned:	
Total horsepower	460
Engines—	
Steam—	
Number	7
Horsepower	430
Gas or gasoline—	
Number	2
Horsepower	30

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[1] Includes operators as follows: Arkansas, 2; Florida, 2.

GRAPHITE

GRAPHITE.

By Joseph Struthers, Ph. D.

Statistics for the mining of graphite were first reported separately at the census of 1880. Table 1 shows the comparative statistics of the mining operations for 1880, 1889, and 1902.

TABLE 1.—*Comparative summary: 1880 to 1902.*

	1902	1889	1880
Number of mines	28	(1)	5
Number of operators	19	(1)	(1)
Salaried officials, clerks, etc.:			
Number	27	(2)	(2)
Salaries	$18,924	(2)	(2)
Wage-earners:			
Average number	164	101	93
Wages	$76,729	$38,329	$24,000
Miscellaneous expenses	$6,039	$6,393	(1)
Cost of supplies and materials	$51,840	$7,734	$2,900
Product:[3]			
Quantity, short tons	27,438	7,000	[4]240
Value	$227,708	$72,662	$49,800

[1] Not reported.
[2] Not reported separately.
[3] The United States Geological Survey reports 3,936,824 pounds of crystalline, valued at $126,144, and 4,739 short tons of amorphous, valued at $55,964, these representing the product marketed, while the Census figures represent the product mined.
[4] Does not include the return for one large producer in New York received too late for tabulation.

The states reporting production in 1880 were New York, North Carolina, and Pennsylvania. In 1889 there is no record of production in North Carolina, but operations in Michigan, New York, Pennsylvania, Rhode Island, and Wyoming were reported. In 1902 mining operations were carried on in 13 states—Alabama, Georgia, Massachusetts, Michigan, Montana, New Mexico, New York, North Carolina, Pennsylvania, Rhode Island, South Dakota, Wisconsin, and Wyoming. The period between 1880 and 1889 does not show so great a development of the industry as that between 1889 and 1902, the increase in the value of production being 213.4 per cent in the later period, as compared with 45.9 per cent in the earlier one; this advance was due largely to the increased demand for graphite in the arts.

There were 12 mines—5 in New York, 3 each in North Carolina and Pennsylvania, and 1 in Alabama—reported as idle during 1902, and 3—1 each in New Hampshire, New York, and Pennsylvania—at which development work was done.

Capital of incorporated companies.—Fifteen of the 19 active operators were organized as incorporated companies. The details of the capitalization of these companies are shown in the following table:

TABLE 2.—*Capitalization of incorporated companies: 1902.*

Number of incorporated companies	[1]15
Capital stock and bonds issued	$2,632,800
Capital stock:	
Total authorized—	
Number of shares	1,571,640
Par value	$2,914,000
Total issued—	
Number of shares	1,299,688
Par value	$2,614,800
Dividends paid	$8,750
Common—	
Authorized—	
Number of shares	1,470,140
Par value	$2,664,000
Issued—	
Number of shares	1,218,188
Par value	$2,384,800
Dividends paid	$6,750
Preferred—	
Authorized—	
Number of shares	101,500
Par value	$250,000
Issued—	
Number of shares	81,500
Par value	$230,000
Bonds:	
Authorized—	
Number	40
Par value	$20,000
Issued—	
Number	36
Par value	$18,000
Interest paid	$1,080
Assessments levied	$1,100

[1] Includes companies distributed as follows: Alabama, 1; Georgia, 1; Massachusetts, 1; Michigan, 2; Montana, 1; New Mexico, 1; New York, 3; Pennsylvania, 2; Rhode Island, 1; South Dakota, 1; Wisconsin, 1.

The total par value of stock and bonds issued was $2,632,800; of this amount 90.5 per cent represents the value of common stock, 8.7 per cent the value of preferred stock, and the remaining eight-tenths of 1 per cent the value of the bonds. The dividends paid during 1902 represent three-tenths of 1 per cent of the par value of stock issued, and the $1,080 paid as interest on bonds constitutes 6 per cent of the par value of all bonds issued.

Employees and wages.—The average number of wage-earners employed during each month of 1902, and their daily rates of pay by occupations, are shown in Table 5. The minimum number of wage-earners shown for any month during the year was in January, 137 men and 1 boy; the maximum number in October, 185 men and 1 boy. Judging by the slight variation in the number of employees, the production, although below the average during the winter and spring months, must have been fairly steady.

Of the total number of wage-earners, 34.8 per cent were paid at rates less than $1.50 per diem, and 65.2 per cent at higher rates. Of the total number, engineers formed 4.8 per cent; machinists, blacksmiths, carpenters, and other mechanics 11 per cent; and miners, the largest class, 53 per cent.

Mechanical power.—A total of 769 horsepower was reported for this industry; 749 horsepower was furnished by 18 steam engines and 10 horsepower by 1 water wheel, while 10 electric horsepower was rented.

Production.—Although the production of graphite has had a very important bearing upon the development of several of the metallic industries in the United States, it was not until 1880 that authentic statistics of production were collected. Since the quantities of graphite which have been exported from the United States are so small as to be negligible in this connection, for all practical purposes the total consumption of graphite within the United States may be assumed as equivalent to the production plus the importation. Table 3, compiled from the reports of the United States Geological Survey, gives the marketed production of natural graphite in the United States, together with the imports, for the period 1880 to 1902, with the production of artificial graphite since 1897. The statistics of production here shown differ from Census figures in that they represent only the marketed output and not the actual quantity mined.

TABLE 3.—PRODUCTION AND IMPORTS OF GRAPHITE: 1880 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	PRODUCTION.[1]							IMPORTS.[2]			
	Total value.	Crystalline		Amorphous		Artificial		Total value.	Unmanufactured		Manufactured, value.
		Quantity (pounds).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.		Quantity (long tons).	Value.	
1880	$49,800	622,500	$49,800					$300,963	5,495	$278,022	$22,941
1881	30,000	400,000	30,000					413,640	7,516	381,966	31,674
1882	31,000	425,000	31,000					389,371	7,521	363,835	25,536
1883	46,000	575,000	46,000					383,670	7,745	361,949	21,721
1884	35,000	500,000	35,000					298,256	7,201	296,293	1,963
1885	26,231	327,883	26,231					207,228	5,565	207,228	
1886	33,242	415,525	33,242					161,111	4,168	161,111	
1887	34,000	416,000	34,000					331,621	8,442	331,621	
1888	33,000	400,000	33,000					353,990	9,290	353,990	
1889	72,662	(3)	72,662					378,057	8,869	378,057	
1890	77,500	(3)	77,500					591,746	12,798	591,746	
1891	110,000	1,559,674	110,000					555,090	10,118	555,090	
1892	87,902	1,398,365	87,902					667,775	11,677	667,775	
1893	63,232	843,103	63,232					865,379	14,437	865,379	
1894	64,010	918,000	64,010					225,720	5,814	225,720	
1895	52,592	611,700	[4]52,592	2,793				260,090	8,811	260,090	
1896	48,460	535,858	[4]48,460	760				437,179	15,230	437,179	
1897	75,879	1,361,706	[4]65,730	1,070		162,382	$10,149	270,952	8,635	270,952	
1898	86,863	2,360,000	[4]75,200	820		185,647	11,663	743,820	13,482	743,820	
1899	199,581	2,900,732	[4]167,106	2,324		405,870	32,475	1,290,649	20,763	1,290,649	
1900	266,439	5,507,855	[4]197,579	611		860,750	68,860	1,390,141	14,417	1,390,141	
1901	286,714	3,967,612	135,914	809	$31,800	2,500,000	119,000	895,010	14,526	895,010	
1902	292,808	3,936,824	126,144	4,739	55,964	2,358,828	110,700	1,168,554	18,501	1,168,554	

[1] For calendar years.

[2] Through 1887, for fiscal years; beginning with 1888, for calendar years.

[3] Quantity not reported.

[4] Includes value of amorphous.

There were 10 long tons of graphite valued at $834, exported from the United States during 1900 as compared with 5 tons valued at $365, exported during 1901. There were no exports during 1902.

The following table shows the world's production of graphite by years, from 1896 to 1901:

TABLE 4.—WORLD'S PRODUCTION OF GRAPHITE: 1896 TO 1901.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

[Quantity in metric tons.]

COUNTRY.	1896		1897		1898		1899		1900		1901	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Total	56,739	$977,865	70,546	$1,787,185	126,772	$9,898,790	85,282	$3,704,942	[1]81,494	[1]$1,761,115	[1]72,427	$5,575,165
United States	931	48,460	1,589	65,730	1,878	75,200	3,771	167,106	3,084	197,579	2,533	167,714
Austria	35,972	410,081	38,504	489,610	33,062	421,058	31,849	395,280	35,033	418,126	29,092	1,918,509
Canada	126	9,455	396	16,240	....	13,628	1,025	24,179	1,744	30,940	2,005	38,780
Ceylon	10,463	411,405	19,275	1,150,885	78,509	9,243,281	29,107	2,904,970	19,168	[2]875,190	22,707	[2]3,205,215
Germany	5,248	72,108	3,861	66,126	4,768	97,946	5,196	120,250	9,248	136,500	1,435	100,000
India			61	316	22	110	1,518	7,572	1,878	9,104	2,580	(3)
Italy	3,148	10,193	5,650	11,800	6,125	17,123	9,900	55,911	9,720	58,720	10,313	52,211
Japan	215	6,925	204	16,075	346	10,265	53	5,110	94	9,118	(3)	(3)
Mexico	620	5,287	907	8,663	1,855	18,257	2,305	22,847	2,561	25,650	762	7,635
Sweden	14	491	99	3,240	30	1,620	535	1,674	84	3,186	56	1,900

[1] Latest available figures used in making up total.

[2] These values are taken from the official yearbooks of the United Kingdom.

[3] Statistics not available.

[4] Includes crude.

The detailed statistics of the industry for 1902 are shown in Table 5.

DESCRIPTIVE.

The name graphite is derived from the Greek *γράφειν*, "to write," and refers to the use of the mineral for that purpose. Graphite is sometimes called "plumbago" or "black lead," because of its lead-like appearance, although it contains no lead. Graphite was known to the ancients. Up to the latter part of the eighteenth century, however, the names plumbago and molybdena seem to have been applied indiscriminately to graphite and to molybdenite (molybdenum sulphide, MoS_2), both of which leave a black mark when rubbed on paper. Graphite appears to have been first distinguished as early as 1565, by Conrad Geissner, but the popular misconception as to the two substances prevailed until 1779, when the famous chemist Scheele showed them to be entirely distinct.

Physical and chemical characteristics.—Graphite occurs as a form of carbon, and constitutes the last stage in the mineralization of vegetable matter. In the first stage of this process the woody tissue is converted into peat; the peat to a lignite; the substance then passes through the range of bituminous coals to semianthracite, anthracite, graphitic anthracite, and finally it is converted into graphite, which is practically pure carbon. There is no strict line of demarcation between these various forms of carbon, which merge gradually into one another. In structure and purity, specimens from different deposits show a wide divergence.

The mineral occurs in two forms, the crystalline and the amorphous. Crystalline graphite is usually found in a compact foliated or granular mass. At times the crystals are in the form of distinct hexagonal plates. The amorphous variety is, as its name implies, without crystalline structure. The term has been used to include a wide range of natural carbonaceous products—such as the graphitic anthracite of Rhode Island, which is of a structure between scaly and granular, and selected samples of which contain as much as 52 per cent of carbon; and the so-called Baraga graphite of Michigan, which in reality is a carbonaceous schist. The crystalline variety consists of finer grades, and hence is used where softness and a smooth uniformity of structure are desirable, as for lubricants or in the better grades of pencils.

Graphite is iron-black or steel-gray in color and has a metallic luster; to the touch it is smooth and soap-like. Its specific gravity varies from 2.015 to 2.583, the variation being due to the impurities—such as iron oxide, alumina, magnesia, lime, and silica—which are present in all natural graphite. Usually, there is also from five-tenths of 1 per cent to 1.3 per cent of hydrogen—a fact which seems to point to an organic origin. Graphite is infusible, and resists the corrosive action of many chemicals and molten metals. These properties render the crystalline variety, with its flake-like form, of great value in the manufacture of graphite crucibles for special purposes—for instance, to resist intense heat in the manufacture of crucible steel; to possess great density at a high heat, as in the refining of gold and silver; and to resist the corrosive action of easily oxidized metals and alloys in a molten condition, as in melting brass, bronze, etc. Although crystalline graphite will burn in oxygen at and above a temperature of 575° C., it is a good conductor of heat and electricity; this property renders it of special value for the manufacture of the commutator brushes used in electrical machines, for use in electroplating, and for electrodes in many electrolytic chemical processes.

In its chemical relations, graphite occupies a position distinct from that of any other form of carbon. The most striking difference is the effect of treatment with fuming nitric acid and potassium chlorate; diamond is unaltered, and amorphous carbon (charcoal) is completely dissolved, but graphite is converted into a compound known as graphitic acid or graphitic oxide ($C_{11}H_4O_5$).

As a fact of mineralogical interest, but one which has no industrial importance, it may be mentioned that meteoric masses have been found containing graphite which in its properties resembles the graphite formed during the cooling of high carbon and pig iron.

Occurrence and mining of crystalline graphite in the United States.—Crystalline graphite is widely distributed throughout the United States, but the known deposits of sufficient extent and purity to warrant working on a commercial scale are few in number. During the past decade the domestic output of high-grade crystalline graphite has been obtained chiefly from the mines near Ticonderoga, Essex county, N. Y. The mines in Chester county, Pa., were reopened in 1897, after a long period of inactivity, and have been in continuous operation since that time. In 1899 the mines in Clay county, Ala., produced a small amount. There has been considerable activity in the exploitation of graphite properties in Bartow county, Ga.; near Dillon, Beaverhead county, Mont.; in Merrimack county, N. H.; in McDowell county, N. C.; at Bloomington, in northern New Jersey; and in many localities in California; but up to the present time the work has been confined chiefly to determining the character and extent of the deposits, and to ascertaining by experiment the best method of concentrating the ore so as to convert it into a salable product. The limited number of graphite mines now producing the crystalline variety of the mineral bears witness to the difficulties encountered in the development of a prospect into a paying property.

The principal mines in New York are at Ticonderoga, Essex county. The graphite is of the foliated variety, occurring in minute scales in the cleavage planes of a seam of gray quartzite. The ore contains an average of 10 per cent of graphite, of which but little more than one-half is extracted by the prevailing method of working. The graphite-bearing bed lies between strata of massive micaceous gneiss, garnetiferous gneiss, and light-colored quartzite entirely free from graphite. The gneiss dips about 20° south. The graphite beds do not conform to this dip, but have a low pitch to the east. There are two mines in the same bed, on different sides of a fault. The graphite-bearing quartzite is from 1 to 5 feet thick in one mine, and from 2 to 15 feet thick in the other. This vein (known as the Hague vein) seems to have been in a line of weakness during the geologic upheavals, for the ore and wall rocks near the surface are very much pulverized, so that, while the ore carries a good percentage of graphite, the yield is small. It is probable that the deepening of the workings will result in finding the graphite in coarse flakes in the unaltered rocks, unless the faulting has occurred along the vein throughout its course. The mines are opened by adit levels, and the mined ore is treated for the separation of the graphite by crushing and washing in a mill near the mines, followed by a further refining at the works of the company at Ticonderoga.

There are numerous limestone deposits in Essex and neighboring counties of New York which contain graphite disseminated throughout the mass, or in small lenses of very rich ore. While a number of these deposits are being promoted and developed, the only ones of apparent promise are on Lead Hill, back of Ticonderoga, and on Warner Hill, between Ticonderoga and Crown Point. It is probable that if any more valuable mines are opened in this section they will be in the graphitic quartzite, as the lenticular bodies in the limestone have proved uncertain.

In Pennsylvania the principal graphite mine is 1 mile east of Chester Springs, Chester county. The mineral occurs in two layers of disintegrated mica schist, one 4 feet and the other 6 feet in thickness. Adit levels have been run in on the hillside, following the layers, and the rock is so disintegrated that most of the ore can be removed by pick and shovel without recourse to blasting. At the mill the ore is crushed in rolls and cleaned in a log washer of the type commonly used at clay works. After being washed it is again ground, refined by pneumatic concentration, and screened into different grades. There are other graphite properties in the state, notably at Byers, several miles below Chester Springs, and at Pikeland, both in Chester county, and also at Mertztown and Boyertown, Berks county. These properties have been productive at various times, but for the most part are now inoperative. The existence of graphite throughout a large part of the ridge extending from Phoenixville to the Brandywine river seems very probable. Occasionally pockets are found which yield nuggets and masses of nearly pure graphite, such as formed the basis of the producing mines in this region, but more often the mineral is associated with iron oxides, quartz, and feldspar, so that the extraction of the graphite involves considerable difficulty.

Concentrating crystalline graphite.—The increased demand for crystalline graphite has led to a careful study of the concentration of low-grade graphite disseminated in flakes. Operative plants have changed and improved their methods, and new concentrating processes are being tested.

There are two common methods of concentrating crystalline graphite from its ore—the wet and the dry. The wet or water method has been developed to a marked degree of efficiency, and is the one now generally used. The mode of procedure is to crush the ore wet, and separate coarsely by stationary buddles, the concentrates being dried and further treated with buhrstones and screens. No mill, however, has adopted either method in its entirety, because the specific gravities of the constituents of the ore vary so little. Several pneumatic processes have lately proved a partial success, but they have been of limited application, on account of the impossibility of removing the small scales of mica which occur in some of the deposits.

Two new features in concentration practice, in both of which the older method of complete submersion beneath the surface is replaced by flotation, are worthy of note: first, the use of petroleum vapor, which, being readily absorbed by graphite, permits the flakes to be more readily separated from the gangue material by flotation; and, second, the heating of the ground product before separation, which makes the flakes of graphite so light that they float on the surface of the water, whence they are removed.

Occurrence and mining of amorphous graphite in the United States.—Under this head are included also the graphitic anthracite of Rhode Island and the so-called Baraga graphite of Michigan. The incentive to develop properties containing amorphous graphite is much less than in the case of the crystalline variety. On account of the limited use of the former, the value of the crude product is only from one-eighth to one-tenth of that of the latter. For the manufacture of graphite crucibles and for many electrical purposes no satisfactory substitute for crystalline graphite has been discovered, while in the case of amorphous graphite there are many other materials of equal suitability for its various uses.

The mining of amorphous graphite in the United States has been of comparatively recent development. During 1902 the product was obtained chiefly from Wisconsin, followed by Michigan, Rhode Island, South Dakota, Wyoming, and New Mexico, in the order named. There are numerous deposits in other states, but none in sufficient quantity or purity to be of commercial value at the present time.

In Wisconsin, the mines near Stevens Point, Portage county, produce graphite which is reported to contain, at times, as much as 74 per cent of carbon. It is utilized in the manufacture of paint, lubricants, and greases.

In Michigan, there are several thousand acres in Baraga county, composed of a carbonaceous schist without a sign of a vein of graphite. This material is ground for paint and is improperly called graphite.

In Rhode Island, the mines near Cranston have been operated for many years. The graphite shows a structure between scaly and granular, and the grade of the product has not until recently exceeded 55 per cent of carbon, the remainder of the ore being silica and iron oxide, with a trace of sulphur. The property was originally a quarry, and in making the open cut the vein has been exposed for a distance of 70 feet or more. A shaft has been sunk, and most of the ore is now obtained from pockets, although it is found also in a few fissure veins.

In South Dakota, there are several graphite properties in the vicinity of Custer containing promising veins of graphite, one of which is reported to be 4 feet in width and of high-grade mineral. At Castle Creek, in Pennington county, 25 miles northwest of Custer, there is a vein which is reported to contain 40 per cent of carbon and to be in contact with a 10-foot layer of graphitized slate.

In New Mexico, considerable exploratory work has been done at the graphite properties 8 miles southwest of Raton, Colfax county.

Occurrence and mining of graphite in foreign countries.—In Ceylon, which is the chief producer of high-grade crystalline graphite, the main deposits are in the western and northwestern provinces. The graphite, which is scaly or fibrous in structure, is found in veins of irregular occurrence and extent, which break through crystalline rocks of the character of granulite. The minerals associated with graphite in the material which forms the vein are feldspar, rutile, pyrite, biotite, and calcite. The country rock is often highly decomposed, and then consists mainly of kaolin and similar decomposition products. The formation of graphite in these deposits has been attributed by Dr. Ernst Weinschenk to the decomposition of vapors carrying carbonic oxide and cyanogen compounds.

In one of the Ceylon mines near Caltura the graphite occurs in a series of veins in gneiss which has become converted, to a depth of 36 feet, into a mass resembling laterite. The indications point to the deposition of the carbon by the decomposition of hydrocarbon vapors, forming a true vein.

The Ceylon mining industry, which is entirely in the hands of the natives, has been profitable for many years, chiefly on account of the purity and consequent high value of the product. The method of mining is extremely primitive. A shaft is sunk to the level of the ground water (from 40 to 200 feet), and drifts are cut from the bottom of the shaft until the air is so bad that the lamps of the miners will no longer burn; the ground is then stoped upward, the waste being dropped behind until the shaft is filled. In some cases the veins are followed by open cuts and galleries. The underground workings are roughly timbered, and powder is used to break the rock. The ore is hoisted by windlass and bucket, or passed out by hand. A peculiar feature of the industry is the opposition to the installation of modern mining machinery and methods, on the ground that the new conditions might be less satisfactory than the older and fairly profitable ones. The mined product is famous for its purity, the analysis of several samples showing a carbon content of from 99.283 to 99.792 per cent.

In Austria, graphite occurs in the provinces of Bohemia, Styria, Moravia, Carinthia, and lower Austria. The chief producing mines are at Schwarzbach, in Bohemia. The deposits, which are lenticular, occur in gneiss, in parallel beds, extending over an area 14 miles long by 10 miles wide.

At Schwarzbach six beds have been exploited for a length of 1,800 feet and to a depth of 300 feet. The mines produce both hard and soft ore, the latter being graded into three classes. The first and second are hand picked, dried, and packed in barrels for the market; the third class and the hard mineral are crushed in water and dressed in tanks, the heavier impurities sinking to the bottom, while the slime, containing the graphite in a state of fine division, is collected in a filter press, and the resultant cakes, containing about 50 per cent of carbon, are dried and shipped to the market.

In Styria, which ranks second in importance, there is found a highly metamorphosed system of carboniferous shales, clay-slates, limestones, and conglomerates with coal seams, the coal of which has passed into graphite. It is very compact, very pure, and often extremely hard, in some cases retaining exactly the appearance of the coal from which it has been derived. The graphite region extends from Leoben to St. Lorenzen, a distance of 25 miles. The most important deposits are at St. Michael, where five parallel beds, varying in thickness from a few inches to several feet, and occurring in grayish-black schist, have been exploited for a length of over 600 feet. The preparation for market consists in simple screening. The product, which contains nearly 80 per cent of carbon, is used in making graphite crucibles.

Other graphite deposits are found in lower Austria, Moravia, and Carinthia; but the mineral, which is associated with granular limestone in gneiss, and is usually amorphous and friable, is too impure to warrant working commercially.

The graphite deposits of Germany are confined to the easternmost corner of Bavaria. In a region bounded on the south by the Danube and on the east by the Austrian frontier are gneisses and gneissose rocks impregnated with scaly graphite. In some places—chiefly in the immediate neighborhood of intercalations of granular limestone, altered by contact metamorphism—the mineral occurs in lenticular masses, rich in carbon. Both the graphite-bearing rock and its near neighbors are highly decomposed, so that kaolin and other decomposition products are found in intimate association with the graphite deposits. The lenticular form of the deposits, their geological relationship with limestone intercalations, and their frequent association with kaolin and other decomposition products, connect them closely with the Bohemian type, from which they are differentiated by the less compact and more crystalline character of the graphite. The genetic connection between the Passau and Ceylon types is very close.

At Borrowdale, England, fine-scale graphite was at one time found in veins in "greenstone porphyry." The gangue material was chiefly calc-spar, brownspar, and quartz, containing nests and lumps of very fine graphite, especially suitable for the manufacture of pencils. These mines, however, have been exhausted.

The mines at Batugol, province of Irkutsk, Siberia, also are practically exhausted. The graphite was finely fibrous and purer than that at Borrowdale. The veins run through a granitic or dioritic rock, while in the closely adjoining limestone (altered by contact metamorphism) are great lumps of pure graphite, suitable only for pencils.

Artificial graphite.—Graphite can be made artificially in several ways, among which are the following:

(1) In the production of cast iron from ore containing a large proportion of carbon, by allowing the molten mass to cool slowly. As cast iron can retain in combination a much larger proportion of carbon when molten than when solid, the cooling of the mass causes the carbon to separate out, forming scales of graphite disseminated throughout the iron. It is to the presence of the scales of graphite that gray pig iron owes its peculiar properties and its gray color. When this form of pig iron is dissolved in acid, the scales of graphite remain as an insoluble residue. When cast iron is kept in a molten condition for a long time, as in the manufacture of converter steel, scales of graphite collect on the surface of the molten metal, forming so-called "kish." This source of artificial graphite is of no commercial importance.

(2) By the reaction or decomposition of various chemical compounds containing carbon, notably the cyanide class of salts. Graphite can not be produced commercially from chemicals on account of the excessively high cost.

(3) By the treatment of certain carbonaceous materials in the electric-arc furnace, which is the process now used on a very large scale.

Pure graphite has many valuable properties, such as high electrical conductivity, great resistance to chemical action, and absence of the property of absorbing gases, which is possessed more or less by all forms of amorphous carbon. Natural graphites of the high degree of purity required for delicate chemical and electrical processes are so expensive that in most cases the cost is prohibitive. The inception of the artificial graphite industry is due to the efforts and experiments of Mr. Edward G. Acheson,[1] who during 1897 manufactured more than 160,000 pounds of this product. In 1901 the output in the United States reached 2,500,000 pounds. At first the operations were confined to the graphitization of carbon electrodes, but since 1899 very large quantities of artificial graphite have been made, to be utilized for purposes for which natural graphite was formerly used. In graphitizing electrodes the ordinary electrode, which is composed of a mixture of petroleum, coke, pitch, and a carbide-forming material (silica or iron oxide), is subjected to the intense heat of an electric-arc furnace. The so-called "artificial graphite" is produced by subjecting anthracite coal, coke, or charcoal, together with a small proportion of some oxide or sulphate, to the intense heat of an electric-arc furnace; the impurities are eliminated, the ash being reduced in some cases to as low as five-tenths of 1 per cent.

The so-called artificial graphite, which is in the form of grains or powders, is used chiefly in the manufacture of paint, dry batteries, and commutator brushes, although a considerable quantity is used in the manufacture of lubricants for high-grade work, in electroplating, and in certain chemical processes which require a carbon of exceptional purity. Experiments have been made with this material as a coating for the grains of high explosives, to prevent the generation of the static charge of electricity, the spark from which is supposed to cause the spontaneous ignition of the powder.

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[1] United States patents Nos. 645284, 645285, 701758, and 711031.

Graphitized electrodes possess special qualities which render them valuable in electrolytic processes for the production of caustic soda and of chlorine and metals in chloride solution, and in electro-metallurgical processes, such as the production of calcium chloride, the electric smelting of copper and iron ores, and the manufacture of various iron alloys.

In spite of the development of artificial graphite, however, in recent years there has been a large increase in the demand for natural graphite, due to the growth of the iron and steel industries; the largely increased use of copper and its alloys; the development of electrical machinery, which calls for graphitized products; and the increased need for special lubricants to be used at comparatively high temperatures.

Uses of graphite.—Graphite is used for making refractory crucibles, stove polish, foundry facings, paint, and lead pencils; as a lubricant; and in powder glazing, electrotyping steam packing, etc.

For the making of crucibles crystalline graphite is required; the fibrous or laminated variety is used, because its superior binding qualities add to the strength of the crucible. The ordinary mixture consists of 50 per cent of graphite, from 35 to 45 per cent of air-dried clay, and from 5 to 15 per cent of sand. The graphite is ground to a fineness of from 40-mesh to 100-mesh size, according to the special use to which the crucible is to be put; if coarse it will give a porous crucible, while if too fine it will be apt to crack when heated, because of its great density. The clay is selected, not on account of its refractoriness, but because of its plasticity. The sand is free from fluxing impurities, such as iron oxide, lime, magnesia, etc., and is sifted through a 40-mesh screen.

In combining the constituents, the clay is made into a thin paste with water, and the graphite and sand are thoroughly mixed in by repeated treatments in an ordinary pug mill. The mass is kept moist for several weeks, in order to insure the expulsion of any air bubbles which may have been formed in the mixing. This stage of the work is called "tempering." A portion of the tempered mixture of the proper weight for a crucible of the desired size is molded into shape on an ordinary potter's wheel. This method is superior to machine molding, because the rotary motion and external pressure cause the flakes of graphite to become arranged nearly parallel to the sides of the molded shape, thus binding the mass together more strongly. The freshly-molded crucibles are inclosed for several hours in a close-fitting sectional mold of plaster, which absorbs a portion of the moisture; they are then dried for a week or ten days at a temperature of from 70° to 80° F., and finally are fired for several days in a common pottery kiln. The use for graphite crucibles of a fusible clay of great plasticity instead of one of high refractoriness is based upon the fact that for the combination of two substances by fusion mechanical contact is absolutely essential, so that, whether the clay be refractory or not, the presence of an inert material between the particles of clay and sand prevents fusion. Furthermore, as soon as the crucible is placed in the kiln the graphite on the outer surface is burned away by the oxidizing gases, permitting contact between the particles of clay and sand; these, reacting upon each other, fuse and form on the outside of the crucible a glaze which protects from oxidation the graphite flakes beneath the surface.

The quantity of the mineral used for making lead pencils is comparatively small, but the quality must be of the best. For use as a lubricant a high grade of the crystalline product is essential. But material of an inferior grade is employed in the manufacture of stove polish, of foundry facings, and of graphite paint, which is used to protect ironwork (as in smokestacks, iron roofs, elevated steel structures, etc.). While crystalline graphite is used to some extent, its special properties are not absolutely required, and hence the amorphous variety, both natural and artificial, is largely employed for these purposes.

TABLE 5.—DETAILED SUMMARY: 1902.

	United States.	New York.	All other states and territories.[1]
Number of mines	28	3	25
Number of operators	19	3	16
Character of ownership			
Individual	3		3
Firm	1		1
Incorporated company	15	3	12
Salaried officials, clerks, etc.			
Total number	27	7	20
Total salaries	$18,924	$6,627	$12,297
General officers—			
Number	1		1
Salaries	$2,600		$2,600
Superintendents, managers, foremen, surveyors, etc.—			
Number	17	3	14
Salaries	$10,112	$3,560	$6,552
Foremen, below ground—			
Number	5	2	3
Salaries	$4,435	$1,815	$2,620
Clerks—			
Number	4	2	2
Salaries	$1,777	$1,252	$525
Wage earners			
Aggregate average number	164	71	93
Aggregate wages	$76,729	$35,583	$41,146
Above ground—			
Total average number	101	36	65
Total wages	$45,288	$19,053	$26,235
Engineers, firemen, and other mechanics—			
Average number	27	12	15
Wages	$16,038	$7,558	$8,480
Miners—			
Average number	33		33
Wages	$12,089		$12,089
Boys under 16 years—			
Average number	1		1
Wages	$150		$150
All other wage earners—			
Average number	40	24	16
Wages	$17,011	$11,495	$5,516
Below ground—			
Total average number	63	35	28
Total wages	$31,441	$16,530	$14,911
Miners—			
Average number	54	33	21
Wages	$27,672	$15,780	$11,892
Miners' helpers—			
Average number	6	2	4
Wages	$2,350	$750	$1,600
All other wage-earners—			
Average number	3		3
Wages	$1,419		$1,419
Average number of wage-earners at specified daily rates of pay			
Engineers—			
$1.50 to $1.74	4		4
$2.00 to $2.24	1	1	
$2.75 to $2.99	2		2
$3.00 to $3.24	1		1
Firemen—			
$1.50 to $1.74	1	1	
Machinists, blacksmiths, carpenters, and other mechanics—			
$1.25 to $1.49	3		3
$1.50 to $1.74	4	2	2
$2.00 to $2.24	2	1	1
$2.50 to $2.74	5	5	
$2.75 to $2.99	4	2	2
Miners—			
$0.75 to $0.99	2		2
$1.00 to $1.24	24		24
$1.25 to $1.49	6	1	5
$1.50 to $1.74	37	30	7
$1.75 to $1.99	3		3
$2.00 to $2.24	5	2	3
$2.25 to $2.49	9		9
$2.50 to $2.74	1		1

	United States.	New York.	All other states and territories.[1]
Average number of wage-earners at specified daily rates of pay—Continued.			
Miners' helpers—			
$1.00 to $1.24	2	2	
$1.25 to $1.49	4		4
Timbermen and track layers—			
$1.50 to $1.74	3		3
Boys under 16 years—			
$0.50 to $0.74	1		1
All other wage-earners—			
$0.75 to $0.99	6		6
$1.00 to $1.24	1		1
$1.25 to $1.49	8		8
$1.50 to $1.74	24	24	
$2.25 to $2.49	1		1
Average number of wage-earners employed during each month			
Men 16 years and over—			
January	137	60	77
February	138	61	77
March	152	63	89
April	149	68	81
May	167	70	97
June	171	78	93
July	163	76	87
August	169	76	93
September	171	80	91
October	185	74	111
November	176	72	104
December	175	74	101
Boys under 16 years—			
January	1		1
February	1		1
March	1		1
April	1		1
May	1		1
June	1		1
July	1		1
August	1		1
September	1		1
October	1		1
November	1		1
December	1		1
Contract work:			
Amount paid	$900		$900
Number of employees	2		2
Miscellaneous expenses:			
Total	$6,039	$1,124	$4,915
Royalties and rent of mine and mining plant	$520	$60	$460
Rent of offices, taxes, insurance, interest, and other sundries	$5,519	$1,064	$4,455
Cost of supplies and materials	$51,840	$19,543	$32,297
Product:			
Total quantity, short tons	27,438	1,375	26,063
Total value	$227,568	$77,497	$150,071
Crude—			
Quantity	24,276	50	24,226
Value	$79,900	$200	$79,700
Refined—			
Quantity	3,162	1,325	1,837
Value	$147,668	$77,297	$70,371
Power			
Total horsepower	769	240	529
Owned—			
Engines—			
Steam—			
Number	18	4	14
Horsepower	749	230	519
Water wheels—			
Number	1	1	
Horsepower	10	10	
Rented—			
Electric, horsepower	10		10

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[1] Includes operators distributed as follows: Alabama, 1; Georgia, 2; Massachusetts, 1; Michigan, 2; Montana, 1 (8 mines); New Mexico, 1; North Carolina, 2; Pennsylvania, 2; Rhode Island, 1; South Dakota, 2; Wisconsin, 1 (2 mines); Wyoming (1 mine, operator reported in South Dakota).

LITHIUM ORE

LITHIUM ORE.

By Joseph Hyde Pratt.

The production of lithium ore has not been reported at any prior census, and there are, therefore, no comparative statistics available. The mining of lithium minerals for their lithia contents has been erratic in the United States, and it is only within the past few years that these minerals have been mined in any quantity. This is due to the small demand for lithium carbonate, which is the principal compound of lithium that is sold. The production for 1901 is stated by the United States Geological Survey to have been 1,750 tons, valued at $43,200. According to the same authority, 440 tons were mined in 1900 in San Diego county, Cal., and probably between 75 and 100 tons were obtained elsewhere for experimental purposes.

The following table is a summary of the industry for 1902:

Table 1.—*Summary: 1902.*

Number of mines or quarries	3
Number of operators	3
Salaried officials, clerks, etc.:	
Number	1
Salaries	$600
Wage-earners:	
Average number	6
Wages	$3,744
Miscellaneous expenses	$200
Cost of supplies and materials	$1,265
Product:	
Quantity, short tons	1,245
Value	$25,750

Detailed statistics by states can not be published without disclosing the business of individual establishments, 2 of which were located in California and 1 in South Dakota. One mine, in South Dakota, was idle. Of the 3 operators 2 were individuals and 1 was a firm.

Employees and wages. Of the total amount, $4,344, paid in salaries and wages, $3,744, or 86.2 per cent, was paid to the wage-earners. There were 2 wage-earners on the average to a mine. The yearly average number of wage-earners employed was 6, the greatest average number, as shown by Table 2, being 23 for July and August, and the least, 5 for September. Four of the 6 miners, or 66.7 per cent of the total, received from $1.75 to $1.99 per day.

Production.—The production of lithium minerals in the United States during 1902 was 1,245 short tons, valued at $25,750. The world's annual production of lithium carbonate, which is the principal salt used, has been variously estimated at from 50,000 to 150,000 pounds. Most of this is manufactured in Germany, and a large proportion of the lithium minerals mined in the United States have been shipped to Germany, being returned in the form of lithium carbonate, quoted in New York at $1.35 per pound; the minerals are worth about $20 per ton f. o. b. at point of shipment. A small amount of ore has been treated at some of the chemical manufacturing plants in New Jersey, but thus far they have been unable to make it a profitable proposition. A company in New York, which controls the larger proportion of the deposits of lithium minerals in San Diego county, Cal., expects to erect a plant on the Pacific coast for the manufacture of lithium salts from their own ores.

If the estimate of 55,000 pounds of lithium salts, reported as the annual consumption in the United States, is correct, over one-third of this amount is imported. To produce this amount of lithium salts would require 371 tons of mineral containing at least 3 per cent of lithia (Li_2O); this indicates the relatively small amount of lithium minerals required to supply the home consumption of lithium salts.

Occurrence and uses.—The minerals which have been sources of lithium salts are lepidolite and spodumene, which contain from 4 to 7.6 per cent of lithia (Li_2O). There is another mineral, amblygonite, which has recently been found in quantity and will very probably be mined as a source of lithium salts. The first two minerals are silicates of aluminum and lithium, while the amblygonite is a phosphate of aluminum and lithium with varying percentages of the other alkalies.

Lepidolite has been the chief source of lithia, although theoretically spodumene contains a considerably higher percentage of lithia. Two of the mines in 1902 produced lepidolite and 1 spodumene, the value of the lepidolite constituting over 70 per cent of the total value of the product shown.

The principal occurrences of lepidolite in the United States are in the vicinity of Pala, San Diego county, Cal. Although it has been known for some years that lepidolite deposits occurred there, it was not until about 1899 that any special work began, and regular shipments were not made until the following year. Lepidolite has also been found in some quantity at Hebron, Auburn, Rumford, and Paris, Me., but thus far no work has been done especially for this mineral at any of these places. The mining has been confined to tourmaline, which is found associated with it. In some cases the lepidolite has been separated and a few barrels shipped.

Spodumene has been found in quantity at Branchville, Conn., where it occurs in a pegmatitic dike in crystals, often of very large size, and in the Black Hills of South Dakota. The latter locality is the most noted one commercially and is probably the only one from which spodumene has been shipped as a source of lithium salts. In South Dakota the mineral occurs in pegmatitic dikes, which were formerly worked for tin.

The only locality where amblygonite has been reported to occur in sufficient quantity to make it a possible commercial source of lithium salts is near Pala, Cal., where it has been found associated with lepidolite.

Although only a few large deposits of these lithium minerals are known in the United States, it is not at all improbable that if the demand for them should increase to any considerable extent other deposits in quantity would be found; but, on account of the present comparatively small demand for the minerals, there is now practically no incentive for investigation.

The demand for lithium minerals is not large, for the reason that the uses of the salts of lithium are very limited; it is these salts that are used in the arts, and not the metal itself. The principal use of the salts is in the preparation of mineral waters and effervescing lithia tablets used for medicinal purposes. Another use that might be made of lithium carbonate and of lithium nitrate, if the price could be reduced sufficiently, is in pyrotechnics for red fire, for which purposes strontium salts are now used.

The following table is a detailed summary of the lithium industry for 1902:

TABLE 2.—*Detailed summary: 1902.*

Number of mines or quarries	3
Number of operators	[1]3
Character of ownership:	
Individual	2
Firm	1
Salaried officials, clerks, etc., superintendents:	
Number	1
Salaries	$900
Wage earners (miners or quarrymen):	
Average number	6
Wages	$3,741
Average number of wage-earners at specified daily rates of pay (miners or quarrymen):	
$1 to $1.24	1
$1.75 to $1.99	4
$3.25 to $3.49	1
Average number of wage-earners employed during each month:	
Men 16 years and over—	
June	21
July	23
August	23
September	5
Miscellaneous expenses:	
Total (rent of offices, taxes, insurance, interest, etc.)	$200
Cost of supplies and materials	$1,265
Product:	
Quantity, short tons	1,245
Value	$25,750

[1] Includes 2 operators in California and 1 in South Dakota.

MARL

MARL.

By Story B. Ladd.

The statistics of marl presented herewith relate to the marl product mined and used as a fertilizer, and are confined to the greensand deposits found in New Jersey, Delaware, Maryland, and Virginia. At the Tenth Census no statistics in regard to marl were published. At the Eleventh Census the total production of marl in the United States for the year 1889, was 139,522 short tons, valued at $63,956. The production was limited to five states, viz, New Jersey, Virginia, North Carolina, Alabama, and Arkansas. In four of the states the production was very small, New Jersey alone producing 99 per cent of the total.

During the period 1889 to 1902 there was a very extensive development in the manufacture of Portland cement from the marls of Michigan, Indiana, Ohio, and New York, in the lake region, resulting in a consumption of over a million cubic yards of the material, but as this was all manufactured into cement it is considered in connection with the statistics for cement.

Table 1 is a summary of the statistics for the marl industry as reported for the year 1902:

Table 1.—*Summary: 1902.*

Number of mines or quarries	11
Number of operators	11
Salaried officials, clerks, etc.	
Number	2
Salaries	$2,100
Wage-earners:	
Average number	13
Wages	$4,769
Miscellaneous expenses	$1,407
Cost of supplies and materials	$2,755
Product:	
Quantity, short tons	12,439
Value	$12,741

Of the 11 mines or quarries for which production was reported, 10 were in New Jersey and 1 was in Virginia. The Virginia mine was in Prince George county and the New Jersey mines were distributed as follows: 1 in Burlington county, 1 in Gloucester county, and 8 in Monmouth county. One hundred and four properties reported to the United States Geological Survey as in operation in 1901 were idle during 1902. All of these were in the state of New Jersey, and were distributed as follows: Burlington county, 52; Camden county, 1; Gloucester county, 2; Monmouth county, 48; and Salem county, 1. As but 1 producer outside the state of New Jersey reported in 1902, the statistics are presented for the United States as a whole.

Capital stock of incorporated companies.—Of the 11 producers, 2 were incorporated companies—1 in New Jersey and 1 in Virginia—but neither was engaged exclusively in mining. Their authorized capitalization consisted of 5,380 shares of common stock, of a par value of $67,300. All of the stock was issued but no dividends were paid on it.

Employees and wages.—But 1 producer reported salaried employees; these were 1 superintendent and 1 clerk. The small number of wage-earners employed—13 by the 11 producers—shows that the work was done largely by the owners themselves. The work is all above ground, being mere excavation. Only one establishment reported the employment of power, with 2 employees classed under "engineers, firemen, and other mechanics." Of the total amount, $6,869, paid for salaries and wages by the 11 producers, the sum of $4,769, or 69.4 per cent, was paid to the 13 wage-earners, and $2,100, or 30.6 per cent, to the 2 salaried employees.

The variation in the number of wage-earners employed at different seasons of the year is shown by Table 3, which gives the average number of men and boys, respectively, employed during each month. The small number of wage-earners reported for each month will not warrant any deductions. It may be said, however, that more laborers find employment late in the autumn and early in the spring, when the farming operations of the proprietors are practically suspended. Thus the range in 1902 was from 10 wage-earners during January and February and during the summer to 17 in November.

In addition to asking the average number of employees and the total amount paid as wages, the schedule called for the number of wage-earners employed at the specified daily rates of pay, and these statistics are also shown in Table 3. The excavation of marl requires no skill and the rates of pay should not be compared with those paid in other mining industries requiring skill and experience. Thirty-eight and four-tenths per cent received less than $1 per day; 30.8 per cent, from $1 to $1.24; and 30.8 per cent, from $1.50 to $1.74.

Supplies, materials, and miscellaneous expenses.—The total amount expended for supplies and materials was $2,755. Most of this is chargeable against 4,267 tons of marl dried and ground. The amounts chargeable against the 8,172 tons of crude marl reported is less than 3 cents per ton. The total amount reported for miscellaneous expenses, $1,407, is also for the most part expense chargeable to the treated product. It was paid for "rent of offices, taxes, insurance, interest, and other sundries," and no expense was reported for "royalties and rent of mine and mining plant." Of the 11 producers, 7 reported no expense for supplies and materials, and 8, no miscellaneous expenses.

Production.—The United States Geological Survey publishes statistics concerning the quantity and value of the marl product of the country produced each year, and Table 2 shows the totals for each year since 1880 and the average price per ton.

TABLE 2.—*Production of marl: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR.	Quantity (short tons).	Value.	Average value per ton.
1880	1,000,000	$500,000	$0.50
1881	1,000,000	500,000	0.50
1882	1,080,000	540,000	0.50
1883	972,000	486,000	0.50
1884	875,000	437,500	0.50
1885	875,000	437,500	0.50
1886	800,000	400,000	0.50
1887	600,000	300,000	0.50
1888	300,000	150,000	0.50
1889	139,522	63,956	0.46
1890	153,620	69,880	0.45
1891	135,000	67,500	0.50
1892	125,000	65,000	0.52
1893	75,000	40,000	0.53
1894	75,000	40,000	0.53
1895	60,000	30,000	0.50
1896	60,000	30,000	0.50
1897	60,000	30,000	0.50
1898	60,000	30,000	0.50
1899	60,000	30,000	0.50
1900	60,000	30,000	0.50
1901	[1] 99,880	124,880	1.25
1902	[1] 12,439	12,741	1.02

[1] Includes crude and manufactured products.

The production for 1902 was 12,439 tons, valued at $12,741. Crude marl contributed 8,172 short tons, and the remaining 4,267 tons were treated by drying and grinding. The former was valued at $4,865 and the latter at $7,876. This shows an average value of $1.02 per ton for both crude and treated marl. The average value per ton for crude marl used as a fertilizer without previous treatment was $0.595; the average for the treated product was $1.845.

The detailed statistics of the marl industry for 1902 are given in Table 3.

DESCRIPTIVE.

Marl in a general sense is a mixture of calcium carbonate and clay, occurring naturally with more or less siliceous sand. It is sometimes compact and sometimes pulverulent, and there is a wide range in the character of the material to which the term is applied in different localities. The term "greensand" is given to marl having a green color, because of the presence of grains of green silicate of iron. Most of the varieties of marl found in the United States conform to the general definition, and have calcium carbonate as their principal constituent. The cretaceous marls of New Jersey, as a rule, contain lime in small and variable amounts, and also considerable potash and phosphoric acid. The fertilizing value is due chiefly to these last two constituents. Potash constitutes from 3.5 per cent to 7 per cent, and phosphoric acid from 1.25 per cent to 9 per cent of the whole. The marls of New Jersey have long been used; in some years very extensively.

Marl improves both the chemical and physical conditions of the soil, neutralizing acidity, making available plant food otherwise insoluble, and promoting nitrification. It is very lasting in its effects, and has been used from ancient times for restoring worn-out and improving barren lands. On account of its bulkiness and the large amounts required to secure beneficial results, marl can be used profitably only in close proximity to the deposits. Mr. James C. Booth, in a report of the geological survey of Delaware for 1841, recommends the use of from 60 to 100 bushels per acre on light soils and from 100 to 200 bushels on clay soils, and states that from 200 to 500 bushels may be used on soils of good quality abundantly supplied with humus. The addition of 10 per cent of quicklime to the marl quickens its action.

TABLE 3.—*Detailed summary: 1902.*

Number of mines or quarries	11
Number of operators	11
Character of ownership:	
Individual	9
Incorporated company	2
Salaried officials, clerks, etc.:	
Total number	2
Total salaries	$2,100
Superintendents, managers, foremen, surveyors, etc.—	
Number	1
Salaries	$1,800
Clerks—	
Number	1
Salaries	$300
Wage-earners:	
Total average number, above ground	13
Total wages	$4,769
Engineers, firemen, and other mechanics—	
Average number	2
Wages	$750
Miners or quarrymen—	
Average number	10
Wages	$3,919
Boys under 16 years—	
Average number	1
Wages	$100
Average number of wage-earners at specified daily rates of pay:	
Engineers, $1.50 to $1.74	1
Firemen, $1 to $1.24	1
Miners or quarrymen—	
$0.75 to $0.99	4
$1 to $1.24	3
$1.50 to $1.74	3
Boys under 16 years—	
Less than $0.50	1
Average number of wage-earners employed during each month:	
Men 16 years and over—	
January	10
February	10
March	10
April	10
May	10
June	10
July	11
August	11
September	11
October	15
November	17
December	13
Boys under 16 years—	
January	1
February	1
March	1
April	1
May	1
June	1
July	1
August	1
September	1
October	1
November	1
December	1
Miscellaneous expenses:	
Rent of offices, taxes, insurance, interest, and other sundries	$1,467
Cost of supplies and materials	$2,755
Product:	
Total quantity, short tons	12,439
Total value	$12,741
Crude—	
Quantity	8,172
Value	$4,865
Dried and ground—	
Quantity	4,267
Value	$7,876
Power owned:	
Total horsepower	50
Engines, steam—	
Number	1
Horsepower	50

MICA

MICA.

By Joseph Hyde Pratt.

The mica industry has probably seen as much variation in value and quantity of product as any other of the nonmetallic mineral industries.

In Table 1 is given a comparative summary of the statistics from 1870 to 1902.

Table 1.—*Comparative summary: 1870 to 1902.*

	1902	1889	1880	1870
Number of mines	49	4	22	(1)
Number of operators	38	(1)	(1)	[2]1
Salaried officials, clerks, etc.:				
Number	21	(1)	(1)	(1)
Salaries	$13,444	(1)	(3)	(1)
Wage-earners:				
Average number	98	185	272	24
Wages	$44,043	$42,174	$65,600	$5,000
Miscellaneous expenses	$12,914	$8,755	(1)	(1)
Cost of supplies and materials	$11,961	$7,408	$6,110	$85
Value of product	$118,849	$52,450	$127,825	$7,000

[1] Not reported. [2] Establishment. [3] Not reported separately.

The 49 mines reported in operation during 1902 were located in the following states: North Carolina, 28; California, 10; South Dakota, 3; Maine, 2; New Hampshire, 2; Virginia, 2; Georgia, 1; and New Mexico, 1. Of the 38 operators, 26 were in North Carolina, 3 in South Dakota, 2 each in Maine, New Hampshire, and Virginia, and 1 each in California, Georgia, and New Mexico. Of these operators, 18 were individuals, 11 were firms, and 9 were incorporated companies. North Carolina was the main producer of mica in the United States; in 1902 the value of its production was 59.8 per cent of the total.

The total amount of salaries and wages paid in 1902 was $15,313 more than the amount reported for 1889 and $8,113 less than at the census of 1880. The production reported in 1902 was 373,266 pounds of cut or sheet, 1,028 short tons of scrap or waste, and 372 short tons rough as mined. This production of sheet mica is about five times that reported in 1880 and nearly eight times that for 1889; but the total value, $118,849, of all the mica produced in 1902, although much more than that shown for 1870, is $8,976 less than the value of the production reported at the census of 1880. This is due in part to the somewhat higher prices received in 1880, and also to the very large quantity of small disks and sheets cut in 1902 for electrical purposes.

The decrease of $75,375 in value between 1880 and 1889 reflects the decrease in production and fall in price caused by the large amount of mica imported from India. The reporting of 196 tons of scrap or waste in 1889 indicates the beginning of the use of mica in the manufacture of wall papers, lubricants, etc.

The principal changes in the mica industry, since the census of 1890, have resulted from the utilization of the scrap mica, which was formerly thrown away as valueless, and the cutting of large quantities of small disks, 1 inch in diameter, and small sheets 1 by 1½ inches and 1 by 2 inches, for electrical purposes. This waste having become of value it is possible to work properties which would otherwise be unprofitable. Many new uses for both sheet and scrap mica have been devised during the past few years, so that although there has been a very large falling off in the amount of sheet used in stoves (which was formerly the principal use of mica) the quantity of all mica used has greatly increased.

The mines that were idle in 1902 number 36, of which 14 were in North Carolina, 5 each in New Hampshire and Idaho, 3 in New Mexico, 2 each in Alabama and South Dakota, and 1 each in Georgia, Nevada, Ohio, Pennsylvania, and Vermont. They were owned by 34 operators, of whom 21 were individuals, 7 were firms, 5 were incorporated companies, and 1 was a cooperative association. The authorized capital stock of the 5 incorporated companies was $1,100,000, of which shares to the value of $229,500 were issued. The assessment levied amounted to $1,600.

Capital stock of incorporated companies.—Table 2 gives the details of the capitalization of the 9 incorporated companies operating productive mines.

Table 2.—*Capitalization of incorporated companies: 1902.*

	United States	North Carolina	South Dakota	All other states[1]
Number of incorporated companies	9	3	2	4
Number reporting capitalization	8	2	2	4
Capital stock (all common):				
Total authorized—				
Number of shares	5,302,000	501,000	3,500,000	1,301,000
Par value	$5,450,000	$550,000	$3,500,000	$1,400,000
Total issued—				
Number of shares	3,150,348	50,100	1,908,248	1,192,000
Par value	$3,254,248	$55,000	$1,908,248	$1,291,000

[1] Includes companies distributed as follows: California, 1; Georgia, 1; Maine, 1; New Hampshire, 1.

Of the authorized capital stock, all of which was common, 59.7 per cent had been issued. South Dakota reported 64.2 per cent of the whole amount authorized and 58.6 per cent of the amount issued.

Employees and wages.—The total number of employees reported for the mica industry in 1902 was 119, comprising 21 salaried employees and an average during the year of 98 wage-earners. They received in salaries and wages $57,487, of which amount $13,444, or 23.4 per cent, was paid out in salaries and $44,043, or 76.6 per cent, was paid out in wages.

The month in which the greatest number of wage-earners was engaged, as shown in Table 6, was August, when the number amounted to 112; the lowest was in January, with 75. The falling off during the winter months of January, February, and March was in "all other states." It is interesting to note that there were no wage-earners under 16 years of age employed.

The average number of wage-earners at specified daily rates of pay is also given in Table 6. The wages received varied from 75 cents to $3.74 per day, the most usual rate, however, being from $1 to $1.24. There were 62 wage-earners whose wages were less than $1.25 per day, and of these 49 were classified as miners. These low wages are accounted for by the fact that most of the mining was carried on in North Carolina, where there is a low scale of wages. The miners in the Western states command higher wages as indicated by the fact that the 12 miners who were reported to have received from $2.50 to $2.74 per day were employed in western mines.

Of the 98 wage-earners, 81 worked above ground and only 17 below ground, indicating that most of the mica mining was done in shallow pits and cuts. It was not extensive enough to require much underground work. The number of wage-earners classified as miners was 70. Of these 58 worked above ground and 12 below ground. One foreman was reported employed below ground; therefore, the total number of underground miners was 13, and of underground employees 18.

Supplies, materials, and miscellaneous expenses.—The total cost of supplies and materials and miscellaneous expenses, reported at the census of 1902 for the mica mining industry was $24,875, of which $11,961 was paid for supplies and materials required in mining the mica; $3,142 for royalties and rent of mines and mining plants; and $9,772 for rent of offices, taxes, insurance, and other sundries.

Mechanical power.—The total horsepower utilized in the mica industry was 201, generated by 8 steam engines with 160 horsepower; 1 gasoline engine with 25 horsepower; and 1 electric motor of 16 horsepower. Of this amount, only 10 horsepower, generated by 1 steam engine, was used in North Carolina.

Production.—The production of mica in 1902 consisted of 373,266 pounds of cut, sheet, or plate, valued at $83,843; of 1,028 short tons of scrap or waste, valued at $13,081; and 372 tons rough as mined, valued at $21,925, making the value of the total production $118,849. The 372 tons of mica rough as mined would yield approximately 150,000 pounds of cut, leaving 297 tons of scrap.

The large increase in the production of sheet mica during the past few years has been accompanied by a large decrease in the production of scrap mica. This decrease is accounted for by the fact that most of the scrap mica now produced is that obtained as waste in the present mining or cutting of the sheet mica, where formerly a very large percentage put on the market was obtained from old dumps from former mining. In the following table is shown the annual production of mica in the United States since 1889, these figures having been published by the United States Geological Survey:

TABLE 3.—*Production of mica: 1889 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	Total value.	CUT OR SHEET		SCRAP OR WASTE.		ROUGH AS MINED.	
		Quantity (pounds).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1889	$50,000	49,500	$50,000	(1)	(1)	(1)	(1)
1890	75,000	60,000	75,000	(1)	(1)	(1)	(1)
1891	100,000	75,000	100,000	(1)	(1)	(1)	(1)
1892	100,000	75,000	100,000	(1)	(1)	(1)	(1)
1893	88,929	51,111	[2]88,929	156	(3)	(1)	(1)
1894	52,388	35,943	[2]52,388	191	(3)	(1)	(1)
1895	55,831	41,325	[2]55,831	118	(3)	(1)	(1)
1896	67,191	49,156	65,441	222	$1,750	(1)	(1)
1897	95,226	82,676	80,774	740	14,452	(1)	(1)
1898	131,098	129,520	103,534	3,999	27,564	(1)	(1)
1899	121,465	108,570	70,587	1,505	50,878	(1)	(1)
1900	147,960	456,283	92,758	5,497	55,202	(1)	(1)
1901	118,578	360,000	98,859	2,171	19,719	(1)	(1)
1902	118,849	373,266	83,843	1,028	13,081	372	$21,925

[1] Not given.
[2] Includes value of scrap.
[3] Included with value of cut or sheet.

For comparison, Tables 4 and 5, taken from the published reports of the United States Geological Survey, are given to show the value of imports of mica since 1880: Table 4 gives the value of imports from 1880 to 1896, and Table 5, the quantity and value from 1897 to 1902.

TABLE 4.—*Value of unmanufactured mica imported and entered for consumption in the United States: 1880 to 1896.*

YEAR ENDING—	Value.	YEAR ENDING—	Value.
June 30—		December 31—	
1880	$12,562	1888	[1]$57,541
1881	5,889	1889	[1]97,351
1882	5,175	1890	[1]207,375
1883	9,884	1891	95,242
1884	28,284	1892	218,938
1885	28,685	1893	147,927
December 31—		1894	125,184
1886	[1]56,754	1895	174,886
1887	[1]49,085	1896	169,085

[1] Including mica waste.

On July 24, 1897, a new classification of imports of mica was adopted, showing "unmanufactured" and "cut or trimmed." The imports are given in Table 5.

TABLE 5.—*Mica imported and entered for consumption: 1897 to 1902.*

YEAR.	Quantity (pounds).	Value.	YEAR.	Quantity (pounds).	Value.
1897.			1900.		
Prior to July 24....	656,118	$140,353	Unmanufactured.	1,892,000	$290,872
After July 24.			Cut or trimmed...	64,391	28,688
Unmanufactured	66,821	10,981			
Cut or trimmed..	226,771	41,068	Total	1,956,391	319,560
Total . .	949,710	192,402	1901.		
1898			Unmanufactured	1,598,722	299,065
			Cut or trimmed ..	78,843	35,989
Unmanufactured..	877,930	115,930			
Cut or trimmed....	78,567	34,152	Total	1,677,565	335,054
Total	956,497	150,082	1902.		
1899			Unmanufactured.	2,149,557	419,362
Unmanufactured..	1,709,849	233,446	Cut or trimmed..	102,299	46,970
Cut or trimmed....	67,293	42,538	Total ..	2,251,856	466,332
Total	1,777,142	275,984			

As is shown in the above table, the imports for mica for 1902 amounted to 2,251,856 pounds, valued at $466,332, which is an increase over the importation of 1901 of 574,291 pounds, valued at $131,278. The main point to be noticed, however, is that this increase is greater than the total value of the production of mica in the United States during 1902, showing that the increasing demand for mica in this country is being supplied largely by foreign countries.

The relatively small production of mica in the United States as compared with the importation can be accounted for partially by the low prices maintained for plate mica, by the uncertainty of the occurrence of mica in the veins, and by the large number of small producers each depending upon one small mine. When the mica in the mines of these small producers begins to give out or becomes poor, they do not have the means to carry the necessary amount of "dead" work. The importation of mica from Canada and India at a low valuation tends also to curtail the production of mica in the United States because of the influence it has on the prices of the mica produced at home. This is especially true of the mica imported from India, which can be mined and landed in this country at a price lower than the cost of production at some of the mines in the United States.

The detailed statistics of the industry for 1902 are given in Table 6.

DESCRIPTIVE.

Occurrence and use.—Mica, in some form or other, is probably familiar to everybody because it is so very widely distributed in nature, being a component part of many of the crystalline and sedimentary rocks. Its commercial value is dependent upon its occurrence in blocks or masses that are capable of being split into sheets a square inch or more in size. Deposits of commercial mica occur for the most part in pegmatitic dikes or veins which are found in granite and hornblende and mica gneisses or schists. These dikes or veins vary in thickness from a few inches to several hundred feet and are often very irregular, having arms or veinlets branching off in many directions. In character, these dikes are similar to granite, and sometimes they are called "coarse granite," and if we could conceive of the constituents of granite being magnified a hundred times or more we would have an appearance similar to a pegmatitic dike.

The mica in these pegmatitic dikes will seldom average over 10 per cent of the contents of the dike and sometimes will be as low as 1 per cent. Often a dike will have the appearance of containing a very high percentage of mica on account of a number of blocks being clustered together in bunches almost touching each other, while in another portion of this same dike the mica will be almost entirely absent for a distance of from 5 to 20 feet; thus the general average of mica in the dike will be from 1 to 10 per cent only. Of the mica obtained from these dikes, usually only from 5 to 25 per cent can be cut into sheet or plate mica. The average is probably about 10 per cent. Occasionally large quantities of mica are mined in which there is not over 1 per cent that can be made into sheet mica. These commercial occurrences of mica are not very abundantly distributed throughout the United States, although rocks in which mica is one of the chief constituents are very common. At the present time deposits of commercial value are known to occur in Alabama, Arizona, California, Colorado, Connecticut, Georgia, Idaho, Maine, Missouri, Nevada, New Hampshire, New Mexico, New York, North Carolina, Rhode Island, South Carolina, South Dakota, Vermont, Virginia, and Wyoming; and in Arkansas there are also deposits which may become of commercial importance. In most of these states the deposits were not worked in 1902. In some of them the deposits were not available on account of their distance from railroads, this being especially true of those in Arizona, Colorado, Nevada, New Mexico, and Wyoming. In others little has been done owing to the uncertainty of the price and the demand. Many of the deposits of Maine have only recently been opened, and therefore have not been extensively developed.

Mica was first produced in the Eastern states along the Appalachian mountains, and twenty years ago mining was carried on vigorously in Connecticut, New Hampshire, North Carolina, and Virginia. In the eastern field the principal mining is in North Carolina, which, since the beginning of the mica industry in the United States, has been the chief producer of the mineral. At just what time the first work was done on the mica deposits of North Carolina is uncertain, and since there is no record of the old mining and none of the inhabitants of this section have any information whatever regarding these old workings, they have been attributed to the Indians. Trees 2 feet and over in diameter have been observed growing from these cuts. Stone implements have been found in some of the old tunnels, indicating the antiquity of these workings. Most of these old mines are located in Mitchell and Yancey counties.

Of the North Central states, South Dakota has been and still is the state in which the largest quantity of mica is produced; while of the Western states and territories, New Mexico has for a number of years been the largest producer, but is now likely to have to give way to California. These California deposits have only been opened up within the past few years, but the mining is now being carried on quite extensively. At the present time the Nevada deposits are too isolated to warrant mining on an extensive scale. The completion, however, of the railroad, which is being constructed from California across Nevada and Arizona to Utah, will make these deposits more available for commercial purposes.

The uses of mica are somewhat varied; there are two forms in which it is used, (1) sheet or plate mica and (2) scrap mica.

Sheet or plate mica.—Mica is cut into sheets of various sizes which are used for stoves, lamp chimneys, incandescent lights, and in electrical apparatus for insulation purposes. While the use of this sheet mica for stoves has decreased very rapidly during the past ten years, there has been a corresponding increase in its use for electrical apparatus. It is also used in place of glass in the manufacture of a great many novelties and in many respects increases the usefulness of the articles made. There was formerly a considerable demand for the larger sheets of mica, but these have been replaced to some extent at the present time by a manufactured product known as micanite, which is made from very small, perfect pieces of mica rearranged and cemented together into larger sheets. For some purposes these manufactured sheets are as satisfactory as the natural ones and are, of course, much cheaper.

The value of sheet or plate mica varies with the size of the sheet and is from 2 cents to $3 per pound. The values of from 2 to 5 cents per pound are for the small disks and rectangular sheets that are cut by machinery and are used extensively in electrical apparatus. The larger sheets are cut by hand and considerable skill is required to cut the largest pattern possible from the crude block of mica.

Scrap mica.—The waste or scrap mica not suitable for cutting into sheets of even the smallest size has a value when ground to a flour, which is used in the manufacture of wall papers, lubricants, fireproofing material, artificial snow, novelties, etc. Coverings for boiler tubes and steam pipes are also manufactured from particles of scrap mica which are not ground but are broken into pieces of approximately the same general dimensions, one-half by one-fourth of an inch. These are then arranged with their longer dimension and face parallel to the length of a wire net coil, pressed into the shape of a pipe or tube, against which the layer of scrap mica is kept tightly in place by means of heavy canvas. A number of the states, especially North Carolina, offer very favorable locations for the erection of plants to manufacture products from scrap mica, as there is usually a supply of available water-power near the deposits.

The commercial value of scrap mica before it is ground is from $8 to $10 per ton, delivered at the railroad, and it is this value that has made it possible to work some of the mines that otherwise would have been shut down, for in some cases this waste mica represents from 75 to 95 per cent of the mica mined. After being ground, the mica is worth from $40 to $60 per ton, according to its mesh.

There are a number of minerals, especially quartz and feldspar, associated with the mica, which in some instances should prove of considerable commercial value as by-products in mining the mica, provided water-power for grinding these minerals can be secured near the source of supply. Occasionally some of the gem minerals, as beryl and tourmaline, are found associated with the mica, and furnish some very handsome cut stones. Some of the pegmatitic mica-bearing dikes are rich in the variety of minerals that they contain, while others have very few besides those typical of a pegmatitic dike. Between forty-five and fifty different minerals have been found associated with mica at the different mines throughout the country.

The small production of mica in the United States as compared with the importation is not due to a deficiency in the supply of the mineral in this country. It is undoubtedly true that in the Appalachian region, especially in the southern area, there are many good deposits of mica yet to be discovered which will yield as rich returns as many of those that have already been mined. It is also true that many of the mines that were worked so extensively twenty years ago, especially those in North Carolina, still contain good deposits of mica which the former owners were prevented from taking out on account of the presence of water, which they were unable to control with the means that they had at hand. Any increase in the duty on mica or any considerable decrease in the importation of mica from India and Canada would cause an increase in the price of mica, and would result undoubtedly in a large and immediate increase in its production in the United States.

TABLE 6.—DETAILED SUMMARY: 1902.

	United States.	North Carolina.	South Dakota.	All other states and territories.¹
Number of mines	49	28	3	18
Number of operators	38	26	3	9
Character of ownership:				
Individual	18	15	1	2
Firm	11	8		3
Incorporated company	9	3	2	4
Salaried officials, clerks, etc.:				
Total number	21	4	9	8
Total salaries	$13,444	$1,411	$9,580	$2,453
General officers—				
Number	6		5	1
Salaries	$4,300		$4,000	$300
Superintendents, managers, foremen, surveyors, etc.—				
Number	12	3	2	7
Salaries	$7,314	$961	$4,200	$2,153
Foremen below ground—				
Number	1	1		
Salaries	$450	$450		
Clerks—				
Number	2		2	
Salaries	$1,380		$1,380	
Wage-earners:				
Aggregate average number	98	50	22	26
Aggregate wages	$44,043	$15,160	$18,288	$10,595
Above ground—				
Total average number	81	38	19	24
Total wages	$37,523	$11,728	$15,900	$9,895
Engineers, firemen, and other mechanics—				
Average number	12	5	3	4
Wages	$6,673	$1,524	$3,740	$1,409
Miners or quarrymen—				
Average number	58	28	12	18
Wages	$25,312	$8,692	$9,000	$7,620
All other wage-earners—				
Average number	11	5	4	2
Wages	$5,538	$1,512	$3,160	$866
Below ground—				
Total average number	17	12	3	2
Total wages	$6,520	$3,432	$2,388	$700
Miners—				
Average number	12	9	1	2
Wages	$4,600	$2,592	$1,308	$700
Miners' helpers—				
Average number	3	2	1	
Wages	$1,280	$560	$720	
All other wage-earners—				
Average number	2	1	1	
Wages	$640	$280	$360	
Average number of wage-earners at specified daily rates of pay:				
Engineers—				
$1.00 to $1.24	2	2		
$1.25 to $1.49	1			1
$1.50 to $1.74	1			1
$3.00 to $3.24	1		1	
Firemen—				
$0.75 to $0.99	1	1		
Machinists, blacksmiths, carpenters, and other mechanics—				
$0.75 to $0.99	1	1		
$1.25 to $1.49	1	1		
$1.50 to $1.74	1			1
$2.00 to $2.24	1			1
$3.50 to $3.74	2		2	
Average number of wage-earners at specified daily rates of pay—Continued.				
Miners or quarrymen—				
$0.75 to $0.99	8	7		1
$1.00 to $1.24	41	29		12
$1.25 to $1.49	2			2
$1.50 to $1.74	3	1		2
$2.00 to $2.24	3			3
$2.50 to $2.74	12		12	
$3.00 to $3.24	1		1	
Miners' helpers—				
$0.75 to $0.99	2	2		
$3.00 to $3.24	1		1	
All other wage-earners—				
$0.75 to $0.99	4	4		
$1.00 to $1.24	3	2		1
$1.25 to $1.49	1			1
$2.50 to $2.74	4		4	
$3.00 to $3.24	1		1	
Average number of wage-earners employed during each month:				
Men 16 years and over—				
January	75	43	28	4
February	76	44	28	4
March	78	44	28	6
April	101	45	28	28
May	98	50	19	29
June	106	53	20	33
July	108	57	20	31
August	112	54	20	38
September	108	55	18	35
October	105	48	19	38
November	104	53	18	33
December	105	54	18	33
Miscellaneous expenses:				
Total	$12,914	$2,952	$7,406	$2,556
Royalties and rent of mine and mining plant	$3,142	$2,592		$550
Rent of offices, taxes, insurance, interest, and other sundries	$9,772	$360	$7,406	$2,006
Cost of supplies and materials	$11,961	$3,121	$4,579	$4,261
Product:				
Total value	$118,819	$71,148	$18,450	$29,221
Cut or sheet mica—				
Quantity, pounds	373,266	303,816	6,000	63,450
Value	$83,843	$65,419	$1,200	$17,224
Scrap or waste mica—				
Quantity, short tons	1,028	845		183
Value	$13,051	$4,729		$8,322
Rough, as mined—				
Quantity, short tons	372	10	205	157
Value	$21,925	$1,000	$17,250	$3,675
Power owned:				
Total horsepower	185	10	115	60
Engines—				
Steam—				
Number	8	1	3	4
Horsepower	160	10	115	35
Gas or gasoline—				
Number	1			1
Horsepower	25			25
Electric motors—				
Number	1		1	
Horsepower	16		16	

¹ Includes operators distributed as follows: California, 1 (10 mines); Georgia, 1; Maine, 2; New Hampshire, 2; New Mexico, 1; and Virginia, 2.

MONAZITE

MONAZITE.

By Joseph Hyde Pratt.

There is no mention of the monazite industry in any previous census report, for the reason that the production of this mineral for commercial purposes did not really begin until 1893. As early as 1879 the existence of monazite in commercial quantities in North Carolina was proved by W. E. Hidden, but it was not until 1887 that the first shipment was made. During that year 12 tons of monazite sand from the Brindletown district, in Burke county, N. C., were shipped for experimental purposes, and in the following two years, 1888 and 1889, a few tons were shipped to a northern company. The statistics for 1902 are summarized in the following table:

Table 1.—*Summary: 1902.*

Number of mines	23
Number of operators	22
Salaried officials, clerks, etc.:	
Number	3
Salaries	$2,100
Wage-earners:	
Average number	88
Wages	$25,318
Miscellaneous expenses	$2,083
Cost of supplies and materials	$256
Product:	
Quantity, pounds	802,000
Value	$64,160

One mine in North Carolina was reported idle during 1902. The industry is one of placer mining and is irregularly carried on in many instances, the expenses of some of the producers being advanced by the operators of a concentrating plant. It was deemed inadvisable to obtain separate statistics for these three or four hundred small and irregular miners. Over half the quantity of monazite produced during 1902 is credited to them. This is accounted for in the report of the concentrating plant which purchased the mineral, the miners selling monazite to such plant being included in its return as employees engaged in mining by the pound, and the total amount paid for the mineral being given as their wages. The number of these irregular contract miners was reduced to 65—the number computed to have been working 300 days during the year—and is included in the statistics here presented.

The number of placer deposits or mines for which statistics were received at the census of 1902 was 23. Of the 22 operators working these mines, 20 were individuals, 1 was a firm, and 1 an incorporated company. The incorporated company had a total authorized capital stock of $500,000, divided into 10,000 shares, of which 20 shares, with a total par value of $1,000, had been issued.

Employees and wages.—Of the total amount, $27,418, reported as paid for salaries and wages, $25,318, or 92.3 per cent, was paid to the wage-earners and $2,100, or 7.7 per cent, to the salaried employees. On an average, there were 3.8 wage-earners to a mine. The average number of wage-earners by months and their daily rates of pay by occupations are given in Table 3. The maximum, 130, was reached in August and the minimum, 20, in November and December. Of the 88 wage-earners, 86 were classed as miners. Of these, 73 received from $1 to $1.24 per day, and 13 from 75 to 99 cents.

Supplies, materials, and miscellaneous expenses.—Only $256 were reported to have been expended for supplies and materials. Next to the amount paid for wages that for miscellaneous expenses, $2,083, is the largest. Of this $1,739, or 83.5 per cent, was paid for royalties and rent of mine and mining plant.

Mechanical power.—Of the 22 operators only 1 reported power. This was a firm in North Carolina, which owned 2 steam engines with a total of 30 horsepower.

Production.—The United States Geological Survey has published annual statistics of the production of monazite, beginning with 1893. These statistics, together with the average value per pound, are shown for each year in the following table:

Table 2.—*Production of monazite: 1893 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

YEAR	Quantity (pounds).	Value.	Average value per pound.
1893	130,000	$7,600	$0.058
1894	546,855	36,193	0.066
1895	1,573,000	137,150	0.087
1896	30,000	1,500	0.05
1897	44,000	1,980	0.045
1898	250,776	13,542	0.054
1899	350,000	20,000	0.057
1900	908,000	48,805	0.054
1901	748,736	59,262	0.079
1902	802,000	64,160	0.08

The total quantity produced during the ten years was 5,383,367 pounds, an average of 538,337 pounds per year. By far the largest quantity was produced in 1895, the next largest in 1900, and the third largest in 1902. The average price during the ten years was 7¼ cents per pound.

The value of monazite has varied from 25 cents per pound, the price received for the production of 1887, to 3 cents per pound received for the less pure sand sold by the small producers who were able to eliminate only a small percentage of the heavy minerals. At the present time the sand mined by the small producer is sold to the concentrators and is paid for on the basis of its value after it has been concentrated as thoroughly as possible, so that during the past year or two the price reported by these small producers has increased from 4 cents per pound for crude sand to 8 or 9 cents per pound for the refined product.

The entire production reported at the census of 1902 is credited to North Carolina. Since the beginning of the industry monazite has been produced chiefly in North Carolina, although at first a considerable quantity was obtained from Spartanburg county, South Carolina.

The production of monazite in commercial quantities became a well established industry in 1893, the output for that year being 130,000 pounds, valued at $7,600; during the next two years the production increased very rapidly, until, in 1895, it amounted to 1,573,000 pounds, valued at $137,150, or about 9 cents per pound. It was at this time that the Brazilian deposits of monazite, which occur in large quantity as beach sands along the seashore in the extreme southern part of the province of Bahia, began to be worked on a considerable scale; the production in the United States was affected thereby to such an extent that by the end of 1896 it had decreased to 30,000 pounds. In 1898 there was again a considerable demand for North Carolina monazite, and the production amounted in that year to 250,776 pounds, valued at $13,542. Since that time the production of this mineral has increased, and at the census of 1902 it was 802,000 pounds, valued at $64,160. It sometimes happens that while the quantity of monazite sand produced in a particular year is more than that for the year following, the value of the production of the latter year is considerably more than that of the former, because of the higher percentage of monazite obtained by a more thorough cleaning of the sand.

The monazite industry is steadily increasing, and there is now a considerable demand for this mineral, not only in this country but also abroad. During 1902 a German company was organized and bought up monazite lands in North Carolina. This company has erected the most complete concentrating plant in the district. Its production is to be shipped abroad.

DESCRIPTIVE.

Occurrence.—The commercial deposits of monazite do not occur in the original rocks, which are granitic mica gneisses and hornblende gneisses, and contain only a fraction of a per cent of this mineral; they are found in the placers of the present streams and rivers, and in the old sand and gravel deposits of former streams. As these gneisses are constantly being decomposed and disintegrated, the monazite is continually being washed down and deposited so that in many cases the top soils form workable deposits for monazite sand. The area in which these deposits are located is in Burke, Cleveland, McDowell, Polk, and Rutherford counties, N. C., and in the northern part of Spartanburg and York counties, S. C. They are found along the following streams: Silver, South Muddy, and North Muddy creeks, and Henry and Jacob forks of the Catawba river, in Burke and McDowell counties; the Second Broad river and its tributaries in McDowell and Rutherford counties; and the Broad river and its tributaries in Cleveland and Rutherford counties, N. C., and Spartanburg and York counties, S. C. All these streams have their sources in the South mountains of North Carolina.

Process of cleaning.—The value of monazite sand is dependent principally upon the oxide of thorium, and to a less extent on the oxides of cerium, lanthanum, and didymium. As the thorium oxide or thoria contents are due to the presence of the mineral monazite, the nearer to a pure monazite that the sand can be cleaned, the higher the percentage of thoria. Formerly a sand containing from 65 to 70 per cent of monazite was considered of very good quality; now, with improved machinery and new methods a sand can be obtained that is over 95 per cent monazite. In washing the sands, the lighter material is readily floated off, but magnetite, menaccanite (or ilmenite), rutile, brookite, garnet, zircon, etc., remain with the monazite. The magnetic minerals, such as magnetite and menaccanite are then removed. Formerly the other minerals could be only partially eliminated, but now, with the improved electro-magnetic separator, the other iron minerals are readily picked out; the final operation is the picking up of the monazite grains, leaving the zircon, corundum, etc. In this way an almost pure monazite concentrate is obtained.

Uses.—The principal use of the oxides of thorium, lanthanum, and didymium is in the manufacture of the cylindrical hoods of the Welsbach and other incandescent gas lights. Small quantities of the cerium oxalate obtained during the process of separating the other oxides are used in pharmacy.

Table 3 is a detailed summary of the monazite industry for 1902.

TABLE 3.—DETAILED SUMMARY: 1902.

Number of mines	23
Number of operators	[1]22
Character of ownership	
Individual	20
Firm	1
Incorporated company	1
Salaried officials, clerks, etc.:	
Total number (superintendents, managers, foremen, surveyors, etc.)	3
Total salaries	$2,100
Wage-earners:	
Total average number	88
Total wages	$25,318
Miners—	
Average number	86
Wages	$21,728
All other wage-earners—	
Average number	2
Wages	$590
Average number of wage-earners at specified daily rates of pay:	
Miners—	
$0.75 to $0.99	13
$1.00 to $1.24	73
All other wage-earners—	
$0.75 to $0.99	1
$1.00 to $1.24	1
Average number of wage-earners employed during each month.	
Men 16 years and over—	
January	27
February	29
March	108
April	118
May	126
June	119
July	127
August	130
September	119
October	113
November	20
December	20
Miscellaneous expenses:	
Total	$2,083
Royalties and rent of mine and mining plant	$1,739
Rent of offices, taxes, insurance, interest, and other sundries	$344
Cost of supplies and materials	$256
Product:	
Quantity, pounds	802,000
Value	$64,160
Power owned:	
Total horsepower	30
Engines—	
Steam—	
Number	2
Horsepower	30

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[1] Operators all in North Carolina.

PRECIOUS STONES

Google

PRECIOUS STONES.

By George F. Kunz.

In the United States precious stones have been generally found by accident; in prospecting for, operating, or developing mines of other minerals; or in the working of gravels containing gold, monazite, etc. With the exception of the figures relating to the number of operators and the value of production, the statistics herewith presented are for properties operated by companies which carry on the search for stones with some approach to regularity. These companies produce sapphire, tourmaline, beryl, chrysoprase, opal, and turquoise. In addition to these, certain quantities of emerald, peridot, several varieties of quartz, such as rock crystal, smoky, rose, gold, and rutilated quartz, amethyst, agate and moss agate, and silicified wood; also garnet (pyrope and rhodonite), amazon stone, chlorastrolite, mesolite, pyrite, anthracite, and catlinite, were produced in this country during 1902, but not on a large scale, nor under conditions suitable to serve as a basis for statistical treatment.

In discussing this subject, consideration of the peculiar condition under which production is carried on, and of the noncommercial uses of the product, is of importance. No comparison of the returns in 1902 with those of the Eleventh Census is practicable, owing to the different methods by which these reports were made up. Moreover, it is difficult to present any careful analysis of the figures, and the results necessarily are uncertain. The data in Table 1 are based upon trustworthy information derived from the operators.

The value of the turquoise produced amounted to $130,000, or 39.6 per cent of the whole, and of sapphire, $115,000, or 35 per cent. Much of the production of precious stones was more or less accidental, picked up by prospectors for other minerals, or by excursionists along the beaches. This fact will explain the apparent inconsistency between the small number of mines and the large number of operators reported. It will be readily understood that in such cases no items of expense are properly chargeable. The statistics following, with the exception noted above, are for those companies actively engaged in the systematic exploitation of precious stone deposits. The peculiar condition existing, however, should not be lost sight of.

There were 3 mines, 1 each in California, New Mexico, and North Carolina, reported idle during 1902.

Table 1.—*Summary: 1902.*

Number of mines or quarries	46
Number of operators	460
Salaried officials, clerks, etc.:	
Number	22
Salaries	$28,687
Wage-earners:	
Average number	108
Wages	$88,017
Miscellaneous expenses	$7,461
Cost of supplies and materials	$17,781
Value of product	$328,450

Capital stock of incorporated companies.—Of the 460 operators reported, 449 are classified as individuals, 1 as a firm, and 10 as incorporated companies. Three of the individuals only, however, are miners of precious stones in the strict sense of the word. Of the 10 incorporated companies 1 is located in Arizona, 3 in California, 2 in Montana, 3 in New Mexico, and 1 in North Carolina. The following table shows the details of their capitalization:

Table 2.—CAPITALIZATION OF INCORPORATED COMPANIES: 1902.

	United States.	Arizona.	California	Montana.	New Mexico	North Carolina.
Number of incorporated companies	10	1	3	2	3	1
Capital stock issued (all common)	$1,562,078	$85,000	$600,078	$400,000	$452,000	$25,000
Total authorized:						
Number of shares	1,461,400	100,000	508,500	400,000	450,400	2,500
Par value	$2,129,000	$100,000	$1,152,000	$400,000	$452,000	$25,000
Total issued:						
Number of shares	1,042,078	85,000	105,078	400,000	450,400	2,500
Par value	$1,562,078	$85,000	$600,078	$400,000	$452,000	$25,000
Dividends paid	$20,000			$20,000		

No bonds or preferred stock appear to have been issued by these companies. Of the 1,461,400 shares of common stock authorized, there were 1,042,978 shares issued.

Employees and wages.—Of the $116,704 reported as paid for salaries and wages, $28,687, or 24.6 per cent, was paid to salaried employees, and $88,017, or 75.4 per cent, to wage-earners. In Table 4 is given the average number of wage-earners employed each month during the year. One hundred and forty-one men were given employment during June, while in March only 87 were reported. The average number for the year was 108. Table 4 shows also the average number of wage-earners at specified daily rates of pay. There were 79 wage-earners, or 73.1 per cent of the whole number, classed as miners. Of these, 61, or 77.2 per cent, received $2 or more per day, and only 18, or 22.8 per cent, less than that amount. Of the total number of employees, 82, or 75.9 per cent, received $2 or more per day, and 26, or 24.1 per cent, less than $2. Four machinists, or other mechanics, were employed, as were also 5 miners' helpers, and 20 employees doing miscellaneous work. All the miners' helpers earned from $3 to $3.24 per day.

Supplies, materials, and miscellaneous expenses.—Next to wages, the principal item of expense was for supplies and materials, for which $17,781 was expended. Of the $7,481 reported as miscellaneous expenses, $437 was for rents and royalties of mining plants, and $7,044 for office rent, taxes, insurance, and other sundries.

The yearly production of precious stones by kinds and value, as reported by the United States Geological Survey, is given in Table 3.

TABLE 3.—PRODUCTION OF PRECIOUS STONES IN THE UNITED STATES: 1896 TO 1902.

[United States Geological Survey, "Mineral Resources of the United States," 1902.]

STONE.	1896	1897	1898	1899	1900	1901	1902
Total	$97,850	$130,675	$160,920	$185,770	$233,170	$289,050	$328,450
Diamond	None.	None.	None.	300	150	100	None.
Sapphire	10,000	25,000	55,000	68,000	75,000	90,000	115,000
Ruby	1,000	None.	2,000	3,000	3,000	500	None.
Topaz	200	None.	100	None.	None.	None.	None.
Beryl (aquamarine, etc.)	700	1,500	2,200	4,000	11,000	5,000	4,000
Emerald	None.	25	50	50	4,000	1,000	1,000
Tourmaline	3,000	9,125	4,000	2,000	2,500	15,000	30,000
Peridot	500	500	500	500	500	500	500
Quartz, crystal	7,000	12,000	17,000	12,000	10,000	10,000	12,000
Smoky quartz	2,500	1,000	1,000	None.	1,000	1,000	2,000
Rose quartz	500	None.	100	100	100	150	200
Amethyst	500	200	250	250	500	500	2,000
Prase	100	None.	None.	None.	None.	None.	None.
Gold quartz	10,000	5,000	5,000	500	2,000	2,000	3,000
Rutilated quartz	500	None.	100	50	50	50	100
Dumortierite in quartz	50	None.	None.	None.	None.	None.	None.
Tourmalinated quartz	None.	None.	None.	None.	None.	1,000	None.
Agate	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Moss agate	1,000	1,000	1,000	1,000	1,000	500	500
Chrysoprase	600	None.	100	100	100	1,500	5,000
Silicified wood (silicified and opalized)	4,000	2,000	2,000	3,000	6,000	7,000	7,000
Opal	200	200	200	None.	None.	None.	150
Garnet (almandite)	500	7,000	5,000	5,000	500	100	None.
Garnet (rhodolite)	None.	None.	None.	None.	20,000	21,000	1,500
Garnet (pyrope)	2,000	2,000	2,000	2,000	1,000	1,000	1,000
Garnet (topazolite)	100	None.	None.	None.	None.	None.	None.
Amazon stone	1,000	500	500	250	250	200	500
Oligoclase	500	25	10	20	20	None.	None.
Moonstone	250	None.	None.	None.	None.	None.	None.
Turquoise	40,000	55,000	50,000	72,000	82,000	118,000	130,000
Utahite (compact variscite)	500	100	100	100	100	250	None.
Chlorastrolite	500	500	5,000	3,000	3,000	3,000	4,000
Mesolite (thomsonite, so called)	500	500	1,000	1,000	1,000	1,000	1,000
Prehnite	100	100	100	50	50	None.	None.
Diopside	200	100	None.	None.	None.	None.	None.
Epidote	250	None.	None.	None.	None.	None.	None.
Pyrite	1,000	1,000	1,000	1,000	2,000	3,000	3,000
Malachite	None.	None.	None.	250	200	100	None.
Rutile	100	800	110	200	100	None.	None.
Anthracite (ornaments)	2,000	1,000	1,000	2,000	2,000	2,000	2,000
Catlinite (pipestone)	3,000	2,000	2,000	2,000	2,000	2,000	2,000
Fossil coral	1,000	500	500	50	50	100	None.
Arrow points	1,000	1,000	1,000	1,000	1,000	500	None.

A detailed summary of the statistics for the mining of precious stones in the United States during 1902, where the operations were followed on a commercial basis and warranted statistical treatment, is given in Table 4.

DESCRIPTIVE.

Precious stones derive their value chiefly from their rarity. Other qualities that influence their value are beauty of color, hardness, and the caprice of fashion. Under this classification a distinction could be made between precious and semiprecious stones, but it is not observed in this discussion. Precious stones include the diamond, the sapphire, the ruby, and the emerald; semiprecious stones include a wide variety of other gem minerals. The opal and the pearl are sometimes classed as precious stones, although the latter is not strictly a mineral product. In ordinary speech the precious or semiprecious stone signifies a gem cut or polished for ornamental purposes. In mineralogy the term is used to designate a class of minerals of sufficient hardness to scratch quartz, which are without metallic luster.

although generally brilliant and beautiful. In archaeology the term is restricted to engraved stones, such as intaglios and cameos. A jewel is a gem that has been mounted.

In the report of the Eleventh Census upon "Mineral Industries," page 669ff, an account is given of the occurrence and production of precious stones in this country during the year 1889. The present discussion treats only of the discovery and production of precious stones in the United States since that time.

Diamond.—The diamond, the hardest of known substances, is pure carbon, which crystallizes in the isometric system, generally in an octahedral form. Its specific gravity is 3.525. It occurs in a great variety of colors, ranging through all the shades of the spectrum, occurring most frequently as white, yellow, or brown, and rarely as red, rose-red, blue, or green. By far the greatest number of diamonds come from South Africa, but they are found also in Brazil, India, Borneo, and occasionally in North America.

In the United States diamonds have been found at various points, but they have been few in number, and mostly of small size. Their occasional occurrence in California and east of the southern Alleghanies has been known for fifty years. Since 1890 a few others have been found in these regions, and some in the Northwestern states, varying from one-third of a carat to 21 carats in weight.

The northwestern diamonds are very interesting as being contained in the deposits of the glacial drift, scattered along an irregular line of some 600 miles, from Wisconsin to the vicinity of Cincinnati, Ohio. All the material distributed by this ancient glacial action has been brought down from the north, and therefore the source of these diamonds is somewhere in the unexplored regions of Canada and not in the United States. Geologists recognize two distinct drift deposits in the Western states, called the older or Illinoian drift, and the later or Wisconsin drift. Some of the diamonds found in Indiana and in Wisconsin are referred to one of these drifts and some to the other, though most of them belong to the later. The whole number of diamonds actually known from these glacial deposits amounts to about 25, over half of which are from Wisconsin and one-third from Indiana.

The localities of discovery during the period since 1890 are as follows:

Alabama.—Shelby county, one of $4\frac{3}{8}$ carats. Lee county, one of 3 carats.

California.—A number of localities, chiefly in the central portion of the state, in connection with the hydraulic gold washings of Amador, Butte, Eldorado, and Nevada counties. A single diamond is reported from Tulare county, and a number of very small ones in the gold sands of streams in Del Norte and Trinity counties. No large stones have been found in California, and nowhere are they abundant enough to lead to any mining for them. Nevertheless some handsome ones have been casually obtained in the central counties above named, chiefly in the ancient gold-bearing gravels overlaid by lava flows, and fragments of diamonds crushed by the stamp mills are not uncommon in the flumes and sluices. Most of the stones found within recent years have come from the vicinity of Placerville, Eldorado county.

Indiana.—Brown county, five—one of 2 carats, others very small. Morgan county, three—one of $3\frac{1}{8}$ carats, others very small.

Kentucky.—Cabin Fork creek, Russell county, one.

Michigan.—Dowagiac, Cass county, one of $10\frac{7}{8}$ carats.

Ohio.—Milford, Clermont county, one of 6 carats.

Tennessee.—Koko creek, Tellico river, Monroe county, several reported. Union Crossroads, Roane county, one of 3 carats. Luttrell, Union county, one of $1\frac{11}{16}$ carats.

Wisconsin.—Plum creek, Rock Elm township, Pierce county, several very small stones. Oregon, Dane county, one of $3\frac{13}{16}$ carats. Kohlsville, Washington county, one of 21 carats. Saukville, Ozaukee county, one of $6\frac{1}{2}$ carats. Eagle, Waukesha county, one of $15\frac{12}{32}$ carats. Burlington, Racine county, one of $2\frac{1}{16}$ carats.

The whole subject of the Indiana occurrence is fully described by the state geologist, Prof. W. S. Blatchley,[1] in his annual report for 1902. The geological features of the region are first treated with special reference to the distribution of the drift deposits in central Indiana. These have been known since 1850 to contain gold, and a large amount of local prospecting and panning has been carried on along the streams for years. The gold is found associated with magnetic iron sand, menaccanite, and other heavy minerals. It is in these auriferous sands that diamonds have been found at intervals for some twenty-five years, but especially of late. Some of the diamonds belong certainly in the second, or later, drift, like most of those in Wisconsin; others found south of that line but within the margin of the older drift belong, perhaps, to the older deposits instead of having been washed out from the later beds and carried south by streams, as formerly supposed. The terms "earlier" and "later" are now frequently replaced by "Illinoian" and "Wisconsin," and designate the two glacial drifts, but these terms may be misconceived as to their geographical signification and hence require explanation. The center of ice movement in the glacial era was determined some years ago by Canadian geologists as having traveled or shifted toward the east from the west. Of the two ice invasions that spread over the northern United States, the earlier is called by some geologists the "Illinoian," as having covered a large part of that state not reached by the later one; while the name "Wisconsin" is applied to the later by Prof. T. C. Chamberlin, because it extended westward to a portion of that state not covered by the earlier, and formed there what he terms the Wisconsin boundary, although its source was far east of the earlier drift, and it forms the main deposit of the Eastern states.

Professor Blatchley's list comprises eight diamonds that he himself has seen, and seven more of which he has credible information. The earliest published mention of the occurrence of diamonds in Indiana was made by the late Prof. E. T. Cox, state geologist, in his annual report for 1878, page 116, although the well-known artist, Mr. Daniel Beard, of New York, owns a fine diamond of about 2 carats found in Indiana before that year.[1] Professor Cox mentions several diamonds, of which this may be one, as found in the drift of Brown and Morgan counties, and refers to them with interest because of their evident transportation from a far northern source. Of the eight stones seen by Professor Blatchley, four are from the newer and four from the older drift, or at least from the area covered by it south of the margin of the newer. The list in detail is as follows:

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[1] Gold and Diamonds in Indiana, by W. S. Blatchley. Twenty-seventh Annual Report of the Department of Geology and Natural Resources of Indiana, Indianapolis, 1902.

1. The Stanley diamond, found in 1900, by Calvin Stanley, while panning for gold in Morgan county, on a branch of Gold creek, 3 miles northwest of Centerton, and 3 miles west of Brooklyn. It was found in the bed of the stream at the base of a cliff of shale. The stone was an octahedron weighing $4\frac{3}{8}$ carats, with a yellow tinge and a small black spot. It was purchased first by Mr. R. L. Royse, of Martinsville, Ind., and by him sold to C. E. Nordyke, of Indianapolis, who had it cut into two stones in Cincinnati. These have a peculiar greenish yellow tint, and weigh respectively $1\frac{1}{4}$ and $1\frac{1}{16}$ carats.

2. The Young diamond, found by a local gold hunter, Mr. W. W. Young, in 1898, on Lick creek in Brown county, $4\frac{1}{2}$ miles south of Morgantown. It is an oblong dodecahedron of $1\frac{21}{32}$ carats, white with a yellow cast, and very clear and flawless. It is retained by the finder.

3. An elongated hexoctahedron, of pink color, but only one-eighth of a carat in weight. It was found, like the last, on Lick creek, by Mr. John Merriman, and now belongs to Mr. Nordyke, of Indianapolis.

4. A yellow hexoctahedron of three-sixteenths of a carat, found by Mr. Merriman on Lick creek. It is now owned by Mr. Royse.

5. A light brownish yellow hexoctahedron of five thirty-seconds of a carat, found and owned by Mr. Royse.

6. A bluish rhombic dodecahedron, weighing eleven-sixteenths of a carat, found by Mr. Merriman on Gold creek, Morgan county, now also belonging to Mr. Royse.

7 and 8. These are pinkish crystals, neither of which exceeds one-eighth of a carat, found in May, 1903, by Mr. Royse. They were taken from the tailings of sluice boxes on the farm of Doctor Cook, near Brey, in Morgan county.

The first, and the last three, from Morgan county, are from the newer or Wisconsin drift, the others, from Brown county, are from the older or Illinoian area.

Sapphires and rubies.—The sapphire, ruby, oriental topaz, oriental amethyst, and oriental emerald are names given respectively to the transparent blue, red, yellow, purple, and green varieties of corundum, which is nearly pure alumina, Al_2O_3. The colors of these minerals are ascribed to the presence of minute quantities of metallic oxides. Their specific gravity ranges from 3.97 to 4.05, and their hardness is 9. Rubies are found in Burma, Ceylon, and Siam. Sapphire also occurs in those countries, as well as at the Simla pass in the Himalayas, and in Australia.

The great hardness of corundum gives it a special value for polishing purposes, and the amount produced for such uses during 1902 has been treated under "Abrasive materials." Although corundum is found in the crystalline rocks along the Appalachian mountains from Massachusetts to northern Georgia, few gems of any special value have been found, except in the Cowee valley in North Carolina, where true rubies are obtained to some extent, although mining has ceased for a few years past.

Other deposits in which these gems are found exist in Montana. Sapphires of the finest quality are now mined in Yogo gulch, and others of much beauty are found at other points in the same state.

Until within a few years, these gems had been found only occasionally in the United States—nearly all of them in North Carolina—and were principally cut from small transparent portions of the colored corundums that were otherwise more or less opaque. Corundum is mined in that state extensively as an abrasive material, and ruby and sapphire are simply transparent varieties of it. The Montana gems began to attract notice about 1869, and for some years they were collected abundantly from the bars of the upper Missouri east of Helena; these were of varied and often beautiful tints of pink, blue, green, and intervening shades, but rarely of the deep colors in favor for jewelry. The latter, the rich blue sapphires equal to those of India, have since been found at Yogo gulch, in Fergus county, and active work in mining them from the rock has been carried on for several years by the New Mine Sapphire Syndicate and the Burke and Sweeney Company. Two other important localities in Montana are at Rock creek, in Granite county, and Dry Cottonwood creek, in Deerlodge county, worked by the American Gem Syndicate Company. The former of these yields a wonderful variety of colors, often very beautiful, but few that have the deep shades most valued in the gem market. No locality in the world has shown such variety of tints in sapphires—pink, reddish brown, brown, yellow, green, etc., with occasionally a ruby of the paler type of Ceylon. Gems of considerable value have been annually mined at Yogo gulch for several years past. Fine sapphires of the "cornflower" and "velvet" blue of the best oriental stones have been obtained, weighing as much as 3 carats, and a few as high as 5 and even 7 carats, after cutting. Besides those used for setting, large quantities of small ones from both these localities have found ready sale for watch jewels and bearings; indeed, more have been sold for this purpose than for gems.

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[1] This diamond, from facts that Mr. Beard has given the writer, must have been found as early as 1820.

True rubies have been found, and to some extent mined, in the Cowee valley, Macon county, N. C. Some of them have the rich and peculiar "pigeon's-blood" color of the finest rubies from Burma, but the crystals are small or imperfect, and the yield thus far has been quite limited. The operations were conducted by the American Prospecting and Mining Company.

Emerald.—True emeralds, suitable for cutting and setting, can hardly be said to be found in the United States. It is true that large and very fine crystals of emerald were obtained at Stonypoint, Alexander county, N. C., in 1877; but these, although valuable and beautiful as specimens, were not clear enough to cut into gems. More recently a locality has been opened at Crabtree, Haywood county, in the same state, where small and handsome emerald crystals, both translucent and opaque, occur thickly in the white feldspar and quartz of a vein of pegmatite (coarse feldspathic granite). This green and white mixture is very pleasing, and as the three minerals have nearly the same degree of hardness, the whole can be cut and polished together, making a novel and beautiful ornamental stone. Pieces are cut *en cabochon*, i. e., rounded, not faceted, showing sections of the emerald crystals in different directions in the white mass. This material has been introduced into ornamental and minor jewel work under the name of "emerald matrix," by the American Gem Company.

Beryl.—Beryl is essentially the same mineral as emerald, though of paler shades and much less esteemed. Fine transparent beryls, however, are choice gem stones, and several varieties of them are found in the United States. Among these are emerald beryls, of rich light-green shades; aquamarines, faintly tinged with green; golden beryls, of a rich yellow; blue beryls, sometimes almost as beautiful as pale sapphires; and rose beryls, of light-pink color. Some very fine gems have been cut from crystals of these kinds, especially from Topsham, Me., in the quarries of the Trenton Flint and Spar Company. Other fine gems come from Connecticut, North Carolina, and Colorado. In North Carolina, near Sprucepine post office, many fine beryls—some of the richest blue color ever found—have been mined by the American Gem Company. The finest and largest aquamarine known is from Stoneham, Me. Golden beryls of much beauty have been cut from material mined at Merryall, in Litchfield county, Conn. Green and blue beryls have been found in North Carolina, and aquamarines at Mt. Antero, Colo. The discoveries of fine gem material are, however, not frequent nor in large amount, so that there is no systematic mining or regular production.

Topaz.—Topaz is a fluosilicate of alumina and crystallizes in rhombic prisms with a hardness of 8. The true topaz occurs but sparingly in the United States, although here and there it has been found fine enough to yield choice cut gems. Still, as with many other gem minerals, there is no locality that furnishes any steady supply. Within recent years a few white topazes have been obtained at the Stoneham, Me., and Chatham, N. H., localities; also at Cheyenne mountain, Pikes Peak, and at Nathrop, Colo. They are generally sherry-colored at the former localities, in crystals weighing up to 3 ounces each; at Nathrop in smaller brilliant crystals.

Very recently a number of topaz crystals have been obtained near Ramona, San Diego county, Cal. The crystals vary from quite small ones of great brilliancy up to 1 or 2 inches long and half that diameter. Most of them are perfectly colorless, but some have the pale blue or greenish blue of the topazes from Sarapulka, in the Urals. The larger crystals are somewhat dull externally, but almost all are clear within and would cut into handsome gems.

Garnet.—The name garnet is used for a well-defined group of minerals very closely related in both chemical and physical properties. They are complex silicates of alumina, with varying amounts of lime, magnesia, iron, manganese, and other metallic oxides, which, by their presence in different proportions and combinations, impart various colors to the compound. All the garnets crystallize in the isometric system. Several of the varieties are richly colored, and when transparent are favorite gem stones, though not of the highest value.

The kinds chiefly used in jewelry are those known as precious garnet, or almandine, Bohemian garnet, or pyrope, and manganese garnet, or spessartite. The two former present deep crimson shades, and the latter is of an orange-red or light red-brown color. These are all found in the United States, but there is no regular production, save to some extent of pyrope, in Arizona and New Mexico, and of a beautiful light purple-red garnet known as rhodonite, an intermediate variety between pyrope and almandine, in Macon county, N. C. This latter is among the discoveries of the last decade, having attracted attention and been more or less mined since 1897, and the stones produced have been cut and sold as rather novel American gems. The locality is in the Cowee valley, where the ruby corundums before alluded to have been found. The garnets occur chiefly in the valley of Masons branch, a small stream flowing from Lisle Knob, a spur of the Cowee mountains. All are found in rather small pieces, but their color is a beautiful light red, and their luster when cut is remarkably brilliant. They were at first taken for almandine, and so reported, but analysis shows that their composition lies between that variety and pyrope, and hence they were given the separate name of rhodonite (from the Greek *rhodon*, a rose). In the years 1900 and 1901 the output of these garnets amounted to $20,000 and $21,000, respectively. It has since fallen off somewhat, but work is actively carried on, and large pieces have been obtained, up to 43 and even 59 carats.

Pyrope garnets of fine quality are found in several localities in New Mexico and Arizona, and are frequently miscalled Arizona rubies. The principal locality in New Mexico is on the Navajo Indian reservation, and the finest large specimen from there is the property of Mr. W. T. Kaufman, of Marquette, Mich. It is more than half an inch in diameter, weighs 11½ carats, and has a magnificent red color, equal to any garnet that the writer has seen from any locality. They are also found at some places in northern Arizona, and one of the finest, from near Fort Defiance, was figured by the writer several years ago.[1] They occur loose in the soil, on or near the surface, and are gathered by Indians, soldiers, and cowboys, principally from around ant hills and scorpion holes, where they are brought up and thrown out by the insects. Their source is doubtless in peridotite rocks, from which they are weathered out in the decomposition of the outcrops. In the years since 1896 the annual sales have been estimated at from $1,000 to $2,000.

Spessartite (manganese garnet) was found in magnificent specimens twenty years ago in the albite mine at Amelia Court House, Va., and splendid gems were cut from these. But unfortunately the mine has been closed and abandoned for years past, and one of the finest localities for American gems has thus ceased yielding. Very recently beautiful crystals have been found at Ramoma, in San Diego county, Cal. Some are 15 millimeters in diameter or more, of a rich orange-brown color, and the smaller crystals exceedingly clear and brilliant. This may prove to be a source of choice gem material, although as yet the amount of it present has not been ascertained.

Many other varieties of garnet are known to exist in various parts of the country, and some gems have been cut from them at times, but there is no regular production. Several kinds are reported in Tulare county, Cal., and one of great rarity and beauty at Carrville, Trinity county, in the same state. This is the emerald-green chrome garnet, known as uvarovite, which furnishes beautiful gems when in crystals of any size. This was reported in 1900 as found in small crystals, lining cavities in chrome iron, very richly colored and brilliant, but none of the crystals was more than 3 millimeters in diameter, and no further exploration seems to have been made since.

Tourmaline.—Tourmaline belongs to the rhombohedral system of crystallization, occurring in prisms, the sides of which are generally striated and channeled. The transparent variety is of a hardness of 7.5, its specific gravity ranges from 3 to 3.25, and in composition it is a very complex silicate of alumina. Many different colors are found, ranging all the way from a colorless variety through red, green, blue, and brown, to black. These differences in color are chiefly due to the varying amounts of manganese and iron present. The gem is dichroitic; thus when viewed through the side it may be a transparent green, but either opaque or yellow-green when viewed endwise of the prism.

Tourmaline was but little known in jewelry ten years ago, although some very beautiful gems had been cut from the transparent red, green, and blue crystals obtained at Paris Hill, Me., and Haddam Neck, Conn. Some mining had been done at these places, and many splendid specimens obtained. But within a few years past, wonderful discoveries of gem tourmaline have been made in southern California, at Pala and Mesa Grande, in San Diego county, and in the San Jacinto mountains in Riverside county. The crystals found at these localities are of great size and beauty, and gems have been cut from them in abundance. A single collection of these crystals has been valued at $10,000. The prevailing colors are pink, salmon, and red, all in very rich shades, also fine green and blue, though less frequently in these colors than those found at Mt. Mica and other localities near Paris, Me. Tourmaline is peculiar in that it often presents two or three different and even contrasting colors in the same crystal, which sometimes shade into each other, but often present a sharp line of contact. Advantage has been taken of this feature, which is marked in the California crystals, to produce in jewelry the novelty of parti-colored gems. Beautiful cut stones may now be seen that are half red and half green, or showing other similar contrasts. Many of the larger stones are somewhat flawed; these are often cut *en cabochon* (rounded), and many also as oriental beads. Some present a fibrous texture, and on cutting yield a cat's-eye effect. Many of the larger and less pure pieces have been cut into regular forms for ecclesiastical and other art work. Remarkable crystals possessing the cat's-eye properties have been found at the mine of the Himalaya Mining Company, at Mesa Grande, California.

There are two mines at Pala, Cal., owned by the Pala Lithia Company, one of which yields beautiful specimens of rather small and opaque pink tourmaline crystals, in radiated groups, in lilac lepidolite (lithia mica), none of which, however, is suitable for gem material. The mine is worked for the lepidolite, as a source of lithia compounds, and specimens find a ready sale to collectors and museums. The other mine, which has only recently been discovered, carries large and splendid crystals of tourmaline of mingled colors, and also a new gem named Kunzite, a transparent lilac spodumene.

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[1] Gems and Precious Stones of North America, 1892, Plate III, fig. A.

The localities of Mesa Grande and San Jacinto, which have been furnishing beautiful tourmaline adapted for use as gems, have been steadily worked for several years. Meanwhile, tourmaline is coming to be generally known and esteemed in jewelry as it never has been before.

The entire output of tourmaline in the country is estimated in the reports of the United States Geological Survey as amounting to $15,000 in 1901 and to $30,000 in 1902.

Kunzite (lilac spodumene).—Reference has been made above, under tourmaline, to the discovery of this new and interesting gem stone at Pala, Cal. This locality is remarkable for its lithia compounds, among which are the colored tourmalines and the spodumene, both of which contain lithia in small amounts, combined with silica, alumina, and other oxides.

The mineral spodumene is usually obtained in large, opaque, whitish crystals, but from time to time small specimens, often richly colored and transparent, are found. The three characteristic varieties of the latter are a clear yellow gem spodumene from Brazil,[1] the green "hiddenite" or "lithia emerald" of North Carolina,[2] and small lilac specimens sometimes found in Connecticut.[3] These last are without doubt remnants of large crystals, which must have been very beautiful. Spodumene is particularly subject to alteration, and when found has usually lost all its transparency and beauty of tint.

Large and magnificent crystals of unaltered spodumene, of rich lilac color, have now been discovered near Pala, San Diego county, Cal., in connection with other lithia minerals.[4] This locality has yielded crystals measuring 10 by 20 by 4 centimeters, perfectly clear, of a rose-lilac tint, varying with the spodumene dichroism from a very pale color when looked at across the prism to a rich amethystine hue observed longitudinally. No such spodumene has ever been seen before, and the discovery is of great mineralogical interest. The crystals have been etched by weathering like the hiddenite variety. When cut and mounted parallel to the base, they furnish gems of great beauty, entirely new in jewelry, and make a notable addition to American gem stones.

An extended investigation into certain optical properties of the gem minerals in the Tiffany-Morgan and Bement collections in the American Museum of Natural History, New York, was conducted jointly by the writer and Prof. Charles Baskerville, of the University of North Carolina, during the autumn of 1903. These experiments developed marked and interesting peculiarities of the new mineral.[5] Doctor Baskerville says of it in the American Journal of Science, July, 1904:

> I have submitted large crystals to the action of ultraviolet light with very positive continued phosphorescence. When submitted to bombardment of the Roentgen rays of high penetration for several minutes, a fluorescence is observed, and on removal to a dark chamber it exhibits a persistent, white luminosity not observed with this class of minerals, as learned by experiments with altered and unaltered spodumene from the localities mentioned, including cut stones and such handsome crystals of hiddenite as afforded by the collections mentioned. I have been able to excite a crystal (2 by 4 by 10 centimeters) by the action of the X rays for five minutes sufficiently to cause it to photograph itself when subsequently placed directly upon a sensitive plate (thin white paper being interposed) and allowed to remain in an especially constructed padded black box in a dark room for a period of ten minutes. The material is penetrated by the rays, as shown by a cathodegraph. The excitation is not superficial, but persists throughout the mass.

Doctor Baskerville submitted crystals to the action of emanations of radium bromide, 300,000 activity, especially imported from the Société Centrale des Produits Chimiques at Paris. After a few minutes' exposure the mineral began to glow, and its phosphorescence was most pronounced after the removal of the radio-active body. A five-minute exposure to 125 milligrams of radium bromide caused 600 grams of the gem material to become luminescent in the dark after removal of the radium preparations. This remarkable property was not exhibited by hiddenite or any other specimens of spodumene examined. Doctor Baskerville proposed for it the name of "Kunzite."

Californite.—Californite (vesuvianite)[6] a mineral which promises to be a notable addition to the increasing list of semiprecious or ornamental stones found in the United States, has recently been discovered in California. This is not a new mineral species, properly, but a compact massive variety of vesuvianite (idocrase). It was first announced in the report of the United States Geological Survey for 1901,[7] by the writer, as having been found by Dr. A. E. Heighway, on the South Fork of Indian creek. 12 miles from Happy Camp and 90 miles from Yreka, in Siskiyou county, Cal. Here a hard and handsome stone, varying in color from olive to almost grass-green, and taking a fine polish, outcrops for some 200 feet along a hillside about 100 feet above the creek, and large masses have fallen into the bed of the creek. At first it was supposed to be jade (nephrite), but upon analysis proved to be vesuvianite. The fallen pieces were in some cases as much as 5 feet square and 2 feet thick, of excellent quality for polishing, and of varying shades of light to dark green. The associated rock is precious serpentine.

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[1] Pisani, Comptes Rendus, 1877, Vol. 84, page 1509.

[2] J. L. Smith, American Journal of Science, 1881, Vol. 21, page 128.

[3] Penfield, American Journal of Science, 1880, Vol. 20, page 259.

[4] American Journal of Science, September, 1903.

[5] The following articles treat of the new mineral:

Science, Vol. XVI, August 28, 1903. On a New Lilac-Colored Spodumene from Pala, Cal. By George Frederick Kunz.

The American Journal of Science, Vol. XVI, pages 264 to 267, September, 1903. A New Lilac-Colored Spodumene from Pala, Cal. By George Frederick Kunz.

Science, N. S., Vol. 18, pages 303, 304, September 4, 1903. Kunzite; a New Gem. By Charles Baskerville.

Ed. note American Journal of Science, Vol. XVI, page 335, October, 1903. The Lilac-Colored Spodumene (Kunzite) from California.

Private reprint on Kunzite, October, 1903. Remarks on Action of Radium on Kunzite. By Sir William Crookes.

Separate reprint from Report, "Mineral Resources of the United States," United States Geological Survey, 1903, pages 53, 54. Spodumene var Kunzite. By George Frederick Kunz.

[6] New York Academy of Sciences, October 19, 1903; New York Min. Club, October 20, 1903.

[7] United States Geological Survey, "Mineral Resources of the United States," 1901, page 747.

A very similar mineral was discovered some years ago at one or two places in the Alps, and, like this, was at first described as jade, but on analysis proved to be massive vesuvianite. The likeness to green jade is very marked in both these and the California mineral, and the mistake is not surprising.

The following analysis was made through Prof. F. W. Clarke, chief chemist of the United States Geological Survey, by Mr. George Steiger, in the spring of 1903:

Analysis of vesuvianite from Siskiyou county, California.

SiO_2	35.85	TiO_2	0.10
Al_2O_3	18.35	P_2O_5	0.02
CaO	33.51	H_2O − (below 100° C.)	0.29
Fe_2O_3	1.67	H_2O + (above 100° C.)	4.18
FeO	0.39		
MgO	5.43	Total	99.84
MnO	0.05		

The analysis is essentially that of a normal vesuvianite, though the percentage of water is unusually high. The lime and the iron are below the average, and the titanium and phosphorus are exceptional occurrences.

The mineral is compact, extremely tough, and readily takes a high polish, quite as beautiful as that of nephrite (jade), with which it was at first confounded. The hardness is 6.5 and the specific gravity (from two determinations) is 3.286. The luster is vitreous, often inclining to resinous, and the streak is white. The color is a yellow leek-green, with inclusions of a darker green, which are generally more translucent than the surrounding mass.

This interesting mineral exists in large quantity, and could be cut into a variety of ornaments, in the same way as jade, nephrite, and chrysoprase. It is a form of vesuvianite distinctive enough to receive a special variety name, which, if appropriate and euphonious, would undoubtedly aid the sale of the stone in the arts. The name of "Californite" has been proposed for it.

The discovery of what appears to be the same mineral has recently been announced from two other localities in California quite remote from the first. One of these was reported by that indefatigable prospector, Mr. M. Braverman, of Visalia, as existing in Burrough, in Fresno county, a mile and a half from Hawkins schoolhouse and 32 miles east of Fresno city. The material is pale olive green, translucent, with darker spots in a paler mass. It breaks with an uneven fracture, slightly splintery and partly crystalline, and hence much resembles the material from Siskiyou county. The other locality is apparently not very far from the last mentioned. It is said to be in Tulare county, near the town of Selma, which, though in Fresno county, is near the Tulare line. Here the mineral is of richer color, at times resembling the tint of apple-green chrysoprase, for which it was at first mistaken.

An analysis was made of the green mineral (No. 1) below, through the courtesy of Prof. F. W. Clarke, chief chemist United States Geological Survey, by Mr. George Steiger. In comparison is shown also the analysis of a remarkable associated mineral (No. 2), which proved to be a peculiar variety of garnet.

Analysis of two minerals from California.

	No. 1, Californite, green.	No. 2, Garnet, white.
SiO_2	36.55	38.59
Al_2O_3	18.89	22.24
Fe_2O_3	0.74	0.45
FeO	0.74	0.36
MgO	2.33	0.64
CaO	35.97	35.97
Na_2O	None	None.
K_2O	None.	None.
H_2O − (below 100° C.)	0.58	0.31
H_2O + (above 100° C.)	3.42	0.80
TiO_2	None.	None.
CO_2	0.91	0.39
F	0.13	0.17
MnO	None.	0.10
BaO	None.	None.
SrO	None	None.
B_2O_3	None	None.
	100.26	100.02
	0.05	0.07
	100.21	99.96

Chlorastrolite and mesolite.—In the region about Lake Superior occur two or three peculiar little minerals that have attained some value as "local" gem stones. These, in the order of their importance, are chlorastrolite, thomsonite (properly mesolite), and lintonite; besides one or two other varieties, rarer and of less account. These are all nearly related in composition, being silicates of alumina with varying amounts of lime and oxide of iron. They are all found as rounded nodules, not from wear, however, but natural, as being the filling of small ovate cavities (originally bubble holes) in the trap rocks of the region. As the rocks decompose these harder nodules fall out, and are rolled on the lake beaches or by streams, and are often supposed to be pebbles, but they are not such in reality. They seldom exceed half an inch in diameter, but when polished they make quite pretty stones, and are in considerable demand for local jewelry, as rings, studs, and the like.

Chlorastrolite is found only at Isle Royale, Lake Superior, where it abounds in the trap and on the beaches. It has a characteristic color, from bluish to olive green, and a peculiar radiated mosaic-like structure or pattern. Prof. N. H. Winchell, of the University of Minnesota, has studied these minerals carefully, and shown that the chlorastrolite passes into a substance identical with the so-called thomsonite, the two forming the extremities of a series of closely-related minerals that fill such cavities in igneous rocks of this character. As the proportion of iron diminishes the chlorastrolite loses its color and its pretty little stellate structure, becomes pale and even whitish, and graduates into a white or pinkish body like the mesolite. The best mesolite comes from Grand Marais, Minn., and is in similar nodules, ranging from white to reddish and brown, in concentric zones or bands. This mineral Professor Winchell shows to be not thomsonite, as supposed, but the related species, mesolite, and this latter name should be substituted in these cases for the other, which is erroneously applied. Lintonite is a green mineral with something of the radiated pattern of chlorastrolite, but belongs really to thomsonite proper.

The demand for these little semigems is pretty steady, and the value of the output is considerable. They are not mined, but simply gathered along the beaches, etc., and the production for several years past is estimated to amount to $1,000 annually for thomsonite (i. e., mesolite) and from $3,000 to $5,000 for chlorastrolite.[1]

Opal.—Prior to 1889 no precious opal had been found in the United States. At about that time, however, and during the subsequent decade, several occurrences of it were discovered, and mining operations were undertaken at some points with apparent promise of successful yield. But for various reasons no important or continuous production has been developed as yet, although the igneous rocks of Washington, Idaho, Oregon, California, Nevada, and Utah, undoubtedly contain much handsome opal.

The first important opening was in 1890, near Moscow, Latah county, Idaho, close to the Washington line. Buildings were erected and a post office called Gem City was established. Fine opal was present in the trachyte rock, and for a year or two there was considerable production. In 1891 the value of the output was estimated at $5,000. For some time past, however, little has been heard of this formerly promising locality.

Other occurrences were noted at about the same time. One of these was in Morrow county, Oreg., where several thousand dollars' worth of specimens were said to have been obtained in 1892, and many were exhibited at the Spokane fair. Another was at Opaline, in Owyhee county, Idaho, and exhibits of these were made in the Idaho section of the Mining Building at the Columbian Exposition of 1893. Another occurrence was reported in 1895, near Salmon city, Lemhi county, Idaho, where beautiful opal was found in bowlders of trachyte, and finally traced to the ledge whence it had come. Many very handsome pieces were obtained, and the mineral was present in great variety of color and quality, but no definite work seems to have been undertaken.

In the same year Mr. Don Maguire, of Ogden, Utah, described an occurrence in Lemhi county, Idaho, on Panther creek. This has been recently opened, and will be referred to again.

In 1894 banded opal in large sheets, with hyalite, was reported from Beaver valley, Utah, near Granite Peak, apparently in connection with an ancient geyser, but no work seems to have been attempted there.

In 1897 other localities of precious opal were described at Durkee, Oreg., and at Dunsmuir, Siskiyou county, Cal. Work was undertaken at the former place, but practically nothing has been heard of it since.

Recently, in 1902, one or more promising occurrences have been announced in southern California, in the region of the Mojave desert. One of these is in San Bernardino county, about 25 miles north of Barstow, the junction of the Santa Fe and California Southern railroads. Here opal occurs in veins and pockets in a porphyritic dike about 2 miles in length. Much of it is semiopal, of various colors, some a beautiful amber-yellow, and with these occur precious and fire opal. The locality is promising, but needs to be explored and developed. In Tulare county, also, are found some beautiful semiopals that might be valuable in ornamental art work. One of these, from near Yokohl, is transparent yellow and amber-like; another is from the chrysoprase mine near Visalia. It is translucent green, and has been called chrysoprase opal, or chrysopal, by the discoverer, Mr. M. Braverman. The Idaho locality at Panther creek, Lemhi county, before alluded to, has been rediscovered and described during 1902. Opal of many varieties and colors is abundant here, in a porphyritic dike, traced for a mile and a half, parallel to the creek, and at times as much as 150 feet wide. Much of it is very beautiful, but it is also very brittle, and goes to pieces in extracting it, so that stones of any size are difficult to procure. This locality, however, when more fully examined, may yet prove to be valuable.

There are many minor occurrences that have been noted and many varieties of semiopal that may hereafter yield material of some value in the arts. Gem opals, however, are not yet produced to any extent or with any regularity in the United States, although there is considerable promise at several points.

Turquoise.—Turquoise is a hydrated phosphate of alumina, containing small quantities of copper, iron, or manganese. The mineral varies in color from a fine sky blue to many shades of bluish green, and to apple green and dark green, which show no blue whatever. The hardness of the mineral is 6, and its specific gravity is 2.75.

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[1] United States Geological Survey, "Mineral Resources of the United States," 1898 to 1902; table of production of precious stones.

Turquoise was almost unknown in the United States when the census of 1890 was taken. A few specimens in collections of minerals attested its existence at some points in Arizona and Nevada, and objects worked by the Indians of the Southwest were known to be abundant, but there was no production of it, and all the turquoise used in jewelry came, as it had for centuries past, from the mines in Khorassan, in eastern Persia. Since then a remarkable change has taken place, and the Southwestern states and territories are now furnishing the main supply for the world. Turquoise has been discovered at a number of points in large quantities and of fine quality. It is known to exist in Arizona, New Mexico, Nevada, and southern California, while some localities are reported in Texas and southern Colorado. The main production is in New Mexico, in Santa Fe and Grant counties, and at Turquoise mountain in Arizona. The California localities operated by the Himalaya and the Toltec companies are northeast of Manvel, in San Bernardino county. At almost every point where the mineral is found there are interesting and conspicuous evidences of ancient workings in pre-Columbian times; in many cases these were plainly both extensive and long continued; stone tools and similar objects are abundant, and at some points remarkable rock carvings are to be seen, especially about the California localities. The Toltec Turquoise Company has also operated other mines near Manvel, Cal., over the line in Lincoln county, Nevada.

Turquoise is now being regularly mined in New Mexico, at perhaps a dozen places, by the Azure Turquoise Company, the American Turquoise Company, the Gem Turquoise Company, and by Mr. A. C. Young; and in Arizona by six companies, among them the Aztec Turquoise Company. In 1902 turquoise was discovered in Alabama, on property of the Otero Company, near Idaho, Clay county, about 95 miles east of Birmingham, in the region of the Talladega mountains. This mineral sometimes loses or changes its color, and for this reason several of the above-named companies engrave a trade-mark upon the back of every stone that they sell as a guarantee that the company will replace it with another stone in case of any failure of quality appearing within six months after its sale to the retail purchaser. Thus, all stones from the American Turquoise Company are marked with an "A," from the Azure Company with a circle, from the Toltec Company with a "T," etc. This assurance to the buyer is a marked improvement on the methods of the Persian dealers, who were wont to decamp for parts unknown during the night after a sale. Some of the companies claim, indeed, that their stones never change color, but they furnish a guarantee, notwithstanding.

In 1900, according to official reports, the output from the oldest and largest mine, at Los Cerrillos, N. Mex. (now called Turquesa), had amounted to a total of over $2,000,000 since 1890. The production from all the American mines was estimated at $118,000 in 1901, and at $166,500 in 1902. A single stone has been sold for as much as $3,000.

Utahite and prosopite.—Several handsome and interesting minerals, related to or resembling turquoise, have been identified in Utah during the last decade. Some of these have been largely sold as specimens, though as yet they have not been found in sufficient quantity to be mined for use in the arts. They would, however, be beautiful ornamental or semiprecious stones. Two of these minerals are utahite and prosopite. The former resembles turquoise in composition, being a hydrous phosphate of alumina; the latter is a fluoride of alumina and lime. Both occur in choice shades of green, due usually to a small amount of copper compounds, and both are hard enough to take a handsome polish.

Utahite, so named by the writer in 1895, was discovered in Cedar valley, in a spur of the Oquirrh mountains, near Camp Floyd, Utah, in the previous year, by Mr. Don Maguire. It belongs to the mineral species variscite, but presents a new and peculiar form. Variscite usually occurs in crystals or incrustations; utahite forms compact nodular masses, ranging from the size of a walnut to that of a cocoanut. These occur in slaty layers in a crystalline limestone, and are generally surrounded with a brown ferruginous crust. In color, the interior mass is of various shades of bright green, generally a very vivid golden green or light emerald; and the nodules, cut across and polished, have been much admired and sought by collectors. The mineral is not very abundant at the locality, and can only be removed from the rock with care by the hands. Pieces could be easily cut for small objects, and would be extremely handsome for such uses, owing to the brilliant and delicate coloring. It has been used to some extent for ring stones, cuff buttons, seal rings, and other purposes as jewelry with considerable success.

Prosopite at first was supposed to be identical with utahite, but an analysis made by Mr. W. J. Hillebrand proved it to be a fluoride of alumina, known already as a rare species of mineral from Saxony, Germany, and from Pikes Peak, Colo., where it occurs, but without the rich blue-green color of that found in Utah. Here it was obtained by Mr. Josiah Beck in 1895 in the Dugway mining district, in Tooele county, in a region of low and desert hills. The mineral was not fully identified until 1899, when the analysis was made and the result published.[1] The prosopite is a beautiful stone, but whether it exists in sufficient amount to be of practical use has not yet been determined.

Anthracite.—There is a small but fairly constant sale in the coal region of eastern Pennsylvania of articles of ornament carved from anthracite coal, such as inkstands, paper weights, etc. These are usually made partly polished and partly rough, so as to show a contrast between the two different kinds of black surfaces. They are sold almost entirely as local souvenirs to persons visiting that part of the country. The sale of such articles has been estimated for some years past at a total varying from $1,000 to $2,000.

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[1] American Journal of Science, January, 1899, pages 53, 54.

Catlinite (pipestone).—This material, celebrated in Indian history and immortalized by Longfellow in "Hiawatha," is used to some extent for making ornaments and souvenirs that are sold to visitors in the region of its occurrence—Pipestone county, in southwestern Minnesota. It is not really a definite mineral species, but essentially an indurated red clay. Among the Indians it has long been held almost sacred as the material for making "pipes of peace." The principal locality where it is found was, and still is, visited by Indians from all parts of the country to obtain it for that purpose, and is still regarded by them as a kind of inviolable spot, where all have the right to come. The United States Government has very properly set apart the land on which the quarry exists as a small reservation, to secure this free right of access to all Indians forever. It is jealously guarded by the native tribes, and it is seldom that large pieces can be secured by white men; hence the supply is rather limited and is likely to remain so. The only large object ever made from this material was a mantelpiece, carved by an Indian artist, with designs from Hiawatha, which was exhibited in the Minnesota building at the Pan-American Exposition of 1901. It had been shown previously at the Columbian Exposition in 1893, and is now in the courthouse at Pipestone, Minn., in the room occupied by the Women's Historical Society, to which organization it belongs. The sale of ornaments and souvenirs made of catlinite is estimated at about $2,000 annually, for some years past.

Fluorspar (Illinois).—The old and celebrated "Shawneetown" region in southern Illinois has lately been yielding fluorite of remarkable beauty. In a lot of specimens recently sent to the writer for examination were cleavage pieces of much beauty from several of these localities, notably the Empire mines and Cave-in-Rock. From the former were large cleavages of rich reddish purple, and of the peculiar sea-blue of that region; in one case the general color was of the latter kind, clouded at points with the former—like the tint of a blue Alabashka topaz with included clouds of Uralian amethyst. Both the purple and the sea-blue varieties at times pass into almost colorless fluor. That received from Cave-in-Rock presents an octahedral cleavage, perfectly transparent and of amber yellow. A cubical crystal received from Rosiclare was pale bluish, becoming nearly colorless.

QUARTZ MINERALS.

Rock crystal.—Rock crystal is a variety of transparent colorless quartz, composed of nearly pure silica. While it is not rare as a mineral, yet it is seldom found in masses of large size. When so found, however, it is valuable for use in the ornamental arts. One or two localities in the Alps, that have been known and worked from Roman times, though very difficult and perilous of access, have furnished material for all the objects in European palaces and museums which have been carved from this substance. In Japan, too, large crystals were formerly obtained, from which were made the polished balls, so much prized by the natives, and afterwards by foreigners, who have now almost drained the country of them by purchase. The main supply in recent years has been derived from Madagascar and Brazil.

Within the last decade very fine rock-crystal masses have been obtained in the United States, especially in California. An important discovery was made in 1891–92 by Mr. James Blackiston, near Placerville, Eldorado county. Here, in a partly decomposed quartz vein, were found crystals ranging from small sizes up to masses of 80 or 90 pounds in weight. Some are clear and flawless, while others have the peculiar and beautiful marking known as "included phantoms." This feature has been caused by successive deposits, and is shown by the appearance of several crystals of identical form, one within another, each being outlined by a thin coating of some other mineral, which delicately colors the otherwise transparent quartz. These coatings in the California crystals are of rich green chlorite. Similar chlorite phantoms in clear quartz have since been found also in San Bernardino county, in the mountains of that name.

The most remarkable discovery of quartz in California, however, was made in 1897, in Calaveras county, at the old Green Mountain mine, in Chile gulch, near Mokelumne Hill. Here, in one of the ancient river channels filled with auriferous gravel and covered by an overflow of lava—a formation characteristic of that region of the state—was found a quantity of enormous quartz crystals, embedded in the old gravel. It is claimed that 12 tons were taken out in the years 1897 and 1898. One giant crystal, surrounded by an attached cluster of smaller ones, weighed over a ton. A number of the finest specimens were sent to New York, and splendid balls were cut from them by machinery especially constructed for the purpose. Two of these balls were a little over 7 inches across, but they are not absolutely flawless. A third, 5½ inches in diameter, without a blemish, was valued at $3,000. The latter, and one of the other two, are in the Tiffany-Morgan collection at the American Museum of Natural History in New York; the other is in the Museum of the Jardin des Plantes at Paris, with the collection of American gem minerals that was prepared for the Pan-American Exposition of 1901.

So far as the gravel deposit was explored, the crystals appeared to be strewn through it, and it would seem to contain a large amount of valuable material, although no work has been done there since 1898. Other localities in California where crystals weighing several pounds have been found are Drum valley, Threerivers, and Yokohl, in the neighborhood of Visalia, in Tulare county.

In Oregon, large transparent masses have been found near Bay City, but no particulars of their occurrence are given.

Some fine rock crystal occurs in North Carolina, in Chestnut Hill township, Ashe county, on a spur of Phoenix mountain, near Long Shoal creek. Here, at two or three spots not far apart, were found pieces up to 50 pounds in weight, and two very large crystals, of 188 and 285 pounds, respectively. A crystal ball, 5 inches in diameter, and a number of art objects, all of American workmanship, made from this material, were shown at the Columbian Exposition at Chicago in 1893. Another find in North Carolina was reported in 1896, from Elkin, in Surry county, by Mr. R. M. Chatham, who described crystals up to 40 pounds in weight. Some large crystals are also known to have been found in South Carolina, and it is probable that much rock crystal adapted for use in the arts, exists in the mountain regions of the South.

Colorado has furnished some fine material, especially that from Mt. Antero, Chaffee county. A polished ball, 6 inches in diameter, from the summit of this mountain was exhibited at the Columbian Exposition.

A find of considerable quantity was reported in 1896, at Cheyenne pass, Wyoming, about 18 miles west of Cheyenne city, but no development at that point appears to have been undertaken.

The quartz crystals of Hot Springs, Ark., have been known for many years and furnish a constant source of business to the farmers of the surrounding country, who collect them and bring them in by the wagon load to sell to local dealers and to tourists. These crystals are not large enough to yield art material, but they are beautiful as specimens, either as single crystals or more frequently in groups. It is estimated that in the year 1896 no less than 15,000 pounds were gathered in Montgomery, Saline, and Garland counties and sold in the city of Hot Springs for $5,000.

Colored varieties.—Among the colored varieties, besides amethyst, of crystalline quartz suitable for use as precious or semiprecious stones, two are important—smoky quartz and rose quartz. Both are found at various points in the United States and have been mined more or less during the past ten years, although there is no large or continuous supply.

Smoky quartz.—The most noted place in which smoky quartz occurs is at and near Pikes Peak, Colo., where it is abundant in fine crystals, in a coarse granite, associated with the beautiful crystals of green feldspar (amazon stone), for which that locality is famous. It is found also at Mt. Antero, in Colorado, where the smoky quartz obtained in 1891 yielded one of the finest faceted stones in the world, measuring 3½ inches in length. It was cut and exhibited at the Columbian Exposition. Much of the material from Pikes Peak is sent abroad for cutting, and returned to be sold at Denver and Colorado Springs, Colo., at Hot Springs, Ark., and other interior resorts, as jewelry to tourists. The annual sales amount to about $10,000, three-fourths of which is for cut stones and one-fourth for specimens.

Large crystals, up to 4 and 5 inches in diameter, have been collected at Brandy creek, in Lemhi county, Idaho. They have been found, too, at Three Mile Gulch, near Helena, Mont., and a gigantic crystal, nearly 2 feet long and weighing 93½ pounds, was found in 1900, on Clear creek, Jefferson county, Mont., by Mr. E. P. Chisolm. Crystals have also been reported at points in South Dakota. A considerable quantity occurs in connection with the colored tourmalines in southern California, both at the San Jacinto mine in Riverside county and those at Mesa Grande in San Diego county.

In the East very fine smoky quartz has been found in Maine and in North Carolina, as well as at some other points. The specimens from Maine are particularly beautiful. Crystals of 40 pounds in weight were reported in 1896, by Mr. R. M. Chatham, from a locality near Elkin, in Surry county, N. C., and it was already well known in the neighboring counties of Alexander, Burke, and Iredell. In Connecticut, at New Milford, some 200 pounds of smoky quartz, worth over $100, was taken out in 1898. But the most valuable yield has been in Oxford county, Me., where as much as 3 tons of crystals were reported by Mr. T. F. Lamb, of Portland, as mined in 1897, on Mt. Apatite. Much has been taken out since, including one perfect crystal 12 pounds in weight, and a polished ball 3 inches in diameter has been cut from material obtained here.

Rose quartz.—The delicate pink variety of quartz known as rose quartz has long been obtained at several points in New England, especially at Albany, Stow, and Paris, in Maine; at Southbury, in Connecticut; also at Bedford, in Westchester county, N. Y. Though a beautiful material, it had been little used in the arts or as a gem until quite recently, when it was tried with some success. In general, and particularly in the case of the specimens from the localities in Maine, the tint varies greatly from an almost colorless variety, sometimes opalescent, to pale pink, salmon, and deep rose. When cut into double *cabochons*, or balls, it sometimes shows the asteria effect, like a star sapphire. Very fine, rich-colored pieces, partly opalescent and in size up to

4 or 5 inches in diameter, have been obtained at Round mountain, near Albany, Me., and a ball of 2¼ inches across, with other cut objects from this locality, were shown at the Columbian Exposition.

Rose quartz occurs also at Acworth, N. H., in the celebrated beryl locality, and a large block of this material, some five feet square by half that thickness, has been set up as a monument in Franklin, N. H., to the late Walter Aiken, of that place. The mass is somewhat fissured, however, and rose quartz is liable to fade in the sunlight, so that neither in texture nor in color is it adapted for monuments or other use out of doors.

In 1894 the occurrence of rose quartz in Iredell and Cabarrus counties, N. C., was announced by Prof. T. K. Brunner. In 1895, 50 tons of it were mined at Theresa, in Jefferson county, N. Y., and its presence was noted in Colorado by Mr. E. H. Saltiel, at the headwaters of Currant creek, in Park county. In the same year Messrs. M. Braverman and W. H. Smith described several places where it occurred in the neighborhood of Visalia, in Tulare county, Cal., especially on the Yokohl river, where about $150 worth was then taken out. It exists in some quantity, and of excellent color, at Yokohl and Threerivers, in the same county, and probably at other points in that section.

By far the most extensive occurrence, however, is in the Black Hills of South Dakota. Specimens were first brought in by Prof. W. P. Jenney on his exploring expedition in 1876, and a fine display of it was made in the South Dakota building at the Columbian Exposition of 1893. The exact locality is near French creek, 6 miles east of Custer, in the county of that name. Here it exists in great quantity and of fine quality, outcropping along a ledge for 500 feet in a vein varying in thickness from a few feet up to 60. The color, as usual, ranges through many shades, from faint pink or even white, to the tint of a ripe watermelon, and in places alters completely within a few inches. Contrary to the general opinion, there is no evidence of its fading by exposure to light, for outside portions, and even rolled bowlders, show in some cases a fine deep coloring. Thus far the mining has been carried on mainly by hand, much in the nature of quarrying. About three-fourths of the stone removed is rejected as lacking color; the rest is sorted and sold according to size and color, chiefly to dealers and collectors, at prices ranging from 5 to 25 cents a pound. One mass weighing over a ton was recently sold to be cut into table tops, 30 by 36 inches in size, which were sent to Paris to fill an order. The production reported to the United States Geological Survey amounted to 4 tons in 1902.

Amethyst.—Amethyst is a variety of quartz of a deep purple or bluish violet color, shading almost to pink. Like ordinary quartz, it is composed of silica, and the coloring is due to the presence of oxides of manganese and iron. Its hardness is about 7, and its specific gravity is slightly above 2.65.

Fine gem material has been found in the United States, though nowhere is it mined with any regularity. The localities from which the finest specimens come are in Maine, Pennsylvania, North Carolina, southern Virginia, and northeastern Georgia, and several discoveries have been made recently in the West. The main developments within the last ten years are the following:

Deer Hill and Stow, in Maine, were noted localities some time ago, but have not yielded much lately. At Denmark, however, in the same state, Mr. G. R. Howe obtained many fine crystals in 1894, and had a number of gems cut that were very richly colored—equal to any from the Ural mountains.

Another old locality was Upper Providence township, in Delaware county, Pa. Here, in 1894, a large amount of amethyst was obtained that yielded gems of the finest quality, one of which was of 33 carats; and another, still larger, is in the Lea collection in the National Museum at Washington.

Virginia has only recently come into notice as a possible source of amethyst production. In 1896 its occurrence, in beautiful crystals, was announced at two points in Goochland county, by Mr. G. L. Chase, and also near Lovingston, Nelson county, by Mr. Benjamin Dillon. In 1902 a promising locality was discovered and opened in Amherst county, near Lowesville.

North Carolina has for years yielded more or less amethyst at various points in Burke, Catawba, Iredell, Lincoln, Wake and other counties. In 1901 mining was begun in Macon county, on Tesanty creek, where a large vein traversing a decomposed granite had been exposed by a landslide. Several thousand dollars' worth of material was taken out, as rich and fine in quality as any ever found in the United States.

Amethyst of excellent quality has been occasionally found in Anderson county, S. C., in Hall and Rabun counties, Ga., and at Amethyst mountain, in Gillespie county, Texas.

The western sources of production are chiefly in Montana. In 1895 a crystal weighing 12 pounds was found at Granite, and in 1900 remarkable discoveries were made in Jefferson county, some 22 miles southeast of Butte, by Mr. A. P. Pohndorf. Here amethyst occurs in fine crystals, curiously mingled with quartz both colorless and smoky. Crystals of black tourmaline so penetrate the quartz as to render it opaque. The amethyst itself is free from these inclusions, though sometimes it forms parts even of the same crystals.

In Colorado, amethyst is reported from Cripple Creek and from localities in Park and Mineral counties, but no special data have been given as to these occurrences.

Good material has been brought from two or three points in Alaska, but there has been no development as yet.

Quartz pebbles.—Natural rolled pebbles of quartz, of various colors, are often beautiful, sufficiently so at times to be applied to some uses in the arts or for cheap jewelry. At many points along the Atlantic coast, visitors to the seaside resorts gather pebbles of attractive aspect, especially those of colorless transparent quartz, and sometimes have them cut as souvenirs. These are the so-called Cape May diamonds, and there is quite an industry at many resorts in gathering pebbles to cut for gems, seals, etc. A good deal of fraud is also practiced upon visitors, all manner of ornaments being sold as material found in the vicinity. At Narragansett Pier, R. I., some local dealers and lapidaries have been known to sell foreign-cut quartz, cairngorm stone, topaz, crocidolite, Ceylonese moonstone, and even glass as stones from the beach. In some cases pebbles found by visitors and entrusted to lapidaries for cutting have been replaced by cut stones imported from Bohemia, Oldenburg, and the Jura, where cutting is done on such a large scale and at such low wages that the stones can be brought here at one-tenth of the cost of cutting, the material itself, in the case of quartz, having but small value. The annual proceeds from the sale of cut stones, and the money expended in cutting them at these and other resorts throughout the country, may amount to $20,000 or more a year, and the sale of specimens to a like sum.

Another ingenious fraud has been practiced at Hot Springs, Ark., where clear, rolled pebbles of colorless quartz, found on the banks of the Ouachita river, are in special demand, being more valued for cutting than the crystals of the vicinity, because of a mistaken idea that they will cut into clearer gems. Fine pebbles of this kind are scarce, and so they have been artificially imitated by putting a number of crystals into a box, which is kept revolving by waterpower. In a few days mutual attrition has rolled and roughened the crystals into beautiful pebbles—so beautiful, indeed, that an expert can distinguish them from the real ones by their more perfect whiteness of surface.

Along the coast of California and Oregon there are various localities where many very attractive pebbles of chalcedony, agate, etc., are found. The principal beaches are at Crescent City, at the northern extremity of California; Pescadero, some 28 miles west of San José; and Redondo, a few miles south of Los Angeles. These pebbles are very abundant and in great variety, and are much sought by visitors. Many are put up and sold in bottles of water, to preserve their bright colors and markings and their translucency; and many are drilled and strung to make chains and similar fancy ornaments. Some of those at Pescadero are little hollow geodes of chalcedony, occasionally an inch long, inclosing a liquid with a moving bubble. These little natural-sealed flasks are found also on the beach at Tampa, Florida.

There are likewise many inland localities—several in California, especially on the shore of Lake Tahoe; also in Colorado, and the beaches of Lake Superior—long famous for their agate pebbles, chlorastrolites, etc.

One special use of quartz pebbles in ornamental art work should be here alluded to. On Plum Island, in Long Island sound, there are quantities of pebbles of colored quartz—amethystine, smoky, yellow, etc.—brought down by glacial action from the crystalline rocks of Connecticut and rolled and rounded on the island beach. These have been used in a very effective manner, in the same way as rounded pieces of colored glass, by leading them for screens, shades, etc., to show their tints by transmitted light. This application was introduced about 1897, by Mr. Louis C. Tiffany, of New York.[1]

Agate and chalcedony.—These minerals are forms of quartz (silica), but differ from those previously noted in being noncrystalline, or at least the crystalline structure, if present at all, is only discernible by the microscope. They are also never transparent, but vary from translucent to nearly opaque. With the exception of colorless chalcedony or white carnelian, they are variously and often richly colored by metallic oxides, principally those of iron and manganese, and furnish a number of semiprecious stones that have long been favorites in jewelry and art work.

There are many localities in the United States where handsome agates and chalcedonies occur, and some of these may hereafter be commercially developed. But with the exception of the little local trade in agate and chalcedony pebbles, already mentioned as carried on at certain of the beach resorts on the Pacific coast (see quartz pebbles, above), and likewise to some extent with the agate pebbles of Lake Superior, there is hardly any continuous production or sale. At one point, however, a deposit of agate occurs that is unequaled in the world, and deserves special mention. This is the agatized forest, or Chalcedony Park, of Arizona, where an area of many square miles is strewn with logs and trunks of an ancient growth of trees, now completely altered to silica, and stained with the richest and most varied hues by the oxides above named. Silicified wood is by no means uncommon, but it rarely presents such beauty of coloring as here, where fallen and broken trunks many feet in length and ranging up to as much as 4 feet in diameter, with the woody structure perfectly visible, are converted into agate and chalcedony of every mingled shade of red, brown, and purple. When polished this makes one of the most beautiful and interesting ornamental stones in the world, and has attracted great admiration abroad as well as in this country. Splendid exhibits of it in the form of table tops, clock bases, pedestals for statuary, and many kinds of minor articles, have been made at the Columbian and Pan-American Expositions and at the Paris Exposition of

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[1] United States Geological Survey, "Mineral Resources of the United States," 1887, page 14.

1900. These have been shown by the Drake Company, of Sioux Falls, S. Dak., who obtained a large amount of the material, and erected machinery and polishing works at that place, operated by waterpower, and succeeded in producing beautiful results. Previously there had been no polishing works in this country that could deal with large pieces of a material as hard as quartz.

The locality is in Apache county, Ariz., a few miles south of the Southern Pacific Railroad from Adamana station, not far from the town of Holbrook. It consists of three open valleys or eroded areas among a wilderness of mesas and buttes. The logs, more or less shattered into pieces and fragments or cylindrical cross sections, lie along these valleys by thousands, having been washed out of the rather soft sandstone that formerly covered the whole region, and which still remains in the intervening hills and buttes. At some points the logs may be seen in place in the sandstone, especially at the celebrated "chalcedony bridge," where a large trunk spans a gully worn in the side of a small hill. Geologically these beds belong to the Triassic formation, equivalent to the brown and red sandstones of New Jersey and the Connecticut valley. But the trees grew at a somewhat earlier time, and were overthrown and buried in the sandstone when that was laid down by an invasion of the Triassic sea. These points have been fully determined by Prof. Lester F. Ward, of the United States Geological Survey, in two visits to the region in 1899 and 1901.

This beautiful material exists in very large quantities, but since access has been made more easy from the railroad, tourists, vandals, and speculators have been coming in and there has been danger of seriously despoiling one of the most remarkable natural curiosities in the country. Some years ago the legislature of Arizona petitioned Congress to set apart the Chalcedony Park as a reservation, and this course was strongly recommended by Prof. Lester F. Ward, after his recent visits. Of course, under Government control, a judicious and reasonable removal of material for use in the arts is now permitted; and under such supervision a permanent supply for legitimate purposes will be assured, but spoliation and speculation will be properly prevented.

The yield reported in the last five years has risen steadily; it was $2,000 in 1898, $3,000 in 1899, $6,000 in 1900, and $7,000 in 1901 and also in 1902.

Chrysoprase.—Another semiprecious stone which has been developed in the United States within the past decade is chrysoprase, a chalcedony of a light green color, caused by the presence of oxide of nickel. This stone has been highly valued for centuries, but is of rare occurrence, and most of that used in jewelry and in the arts has been obtained from Silesia. Its existence in North America had been recognized at some points before, but the only promising locality was at Riddles, Douglas county, Oreg. Mr. George W. Smith, a surveyor, obtained specimens in Tulare county, Cal., as far back as 1878. These he submitted to experts, who pronounced them to be true chrysoprase. The first who positively identified them as such, by actual determination of the nickel oxide, was Mr. M. Braverman, of Visalia, Tulare county, who is well known for his enthusiasm in locating and collecting California minerals. From that time specimens were gathered and sent quite widely to museums and cabinets; but not for some years was its commercial value appreciated. When that became known, systematic development was attempted, the neighborhood was prospected, and other occurrences discovered, so that now there are not fewer than five localities in Tulare county where chrysoprase is known to occur. The first of these to be discovered was the one at Venice Hill, 12 miles northeast of Visalia; the others are on Stokes mountain, on the Tule river, on Deer creek, and at Lindsay, 16 miles south of Visalia. Mr. Braverman has been active in the search for these localities, and has presented to the California State Mining Bureau a very fine specimen from the last-named place. The veins which it forms are of no great thickness, and much of the material is flawed and cracked, or too pale to be valuable. Still a large quantity of fine chrysoprase has been obtained and cut, from these several localities, especially the last two and the first. The total production for several years did not much exceed $100 annually, but since a new company took up systematic work two years ago the yield rose to $1,500 in 1901, and $15,000 in 1902. Most of the material is cut into squares, ovals, etc., for rings and studs, and into small pieces of various shapes for inlaying as mosaic.

Within the past year a promising locality has been discovered in North Carolina, at Morganhill, in Buncombe county, some 16 miles from Asheville. Here it occurs in several parallel seams or veins quite near to each other; the color is pale at the surface, but becomes deeper below. No extensive work has yet been done here, although some very rich green material has been cut and placed on the market, and the outlook is favorable.

Moss agate.—The name "moss agate" is applied to a variety of translucent chalcedony, usually nearly colorless, that is penetrated by minute branching or "dendritic" (tree-like) crystallizations of oxide of manganese or of iron, the former black, the latter brown or reddish. It has long been a favorite semiprecious stone in Europe and the East, but large pieces are rare. Small rounded nodules of it are abundant at various places in the West, particularly in Wyoming. In 1893 large masses were found near Hartville, Wyo., occurring in a vein 8 or 10 inches thick in limestone. Slabs of 2 or 3 feet in length could be taken out, according to Mr. H. A. Crane, of Hartville, who described its occurrence, and table tops made of it were shown in the Wyoming section of the World's Columbian Exposition at Chicago. The translucent white slabs, with moss-like markings in black, are very beautiful.

Two other localities in which fine moss agate has been found are reported in Wyoming, one 47 miles and the other 75 miles northwest of Cheyenne. No important developments, however, appear to have been made at these points.

TABLE 4.—DETAILED SUMMARY: 1902.

	United States.	California.	Montana.	New Mexico.	All other states and territories.[1]
Number of mines or quarries	46	31	3	8	4
Number of operators	460	47	3	60	350
Character of ownership:					
Individual	449	44	....	57	348
Firm	1	....	1	....	....
Incorporated company	10	3	2	3	2
Salaried officials, clerks, etc.:					
Total number	22	7	2	3	10
Total salaries	$28,687	$9,087	$1,730	$5,160	$12,710
General officers—					
Number	3	....	....	....	3
Salaries	$2,500	....	....	....	$2,500
Superintendents, managers, foremen, surveyors, etc.—					
Number	13	5	1	2	5
Salaries	$21,247	$6,787	$1,250	$4,200	$9,010
Foremen below ground—					
Number	2	1	....	1	....
Salaries	$2,760	$1,800	....	$960	....
Clerks—					
Number	4	1	1	....	2
Salaries	$2,180	$500	$480	....	$1,200
Wage-earners:					
Aggregate average number	108	19	39	36	14
Aggregate wages	$88,017	$12,591	$43,664	$22,087	$9,675
Above ground—					
Total average number	72	12	24	22	14
Total wages	$56,058	$6,937	$25,514	$13,932	$9,675
Engineers, firemen, and other mechanics—					
Average number	4	....	3	1	....
Wages	$3,867	....	$3,267	$600	....
Miners or quarrymen—					
Average number	50	12	14	14	10
Wages	$39,088	$6,937	$14,760	$10,056	$7,335
All other wage-earners—					
Average number	18	....	7	7	4
Wages	$13,103	———	$7,487	$3,276	$2,340
Below ground—					
Total average number	36	7	15	14	....
Total wages	$31,959	$5,654	$18,150	$8,155	....
Miners—					
Average number	29	5	10	14	....
Wages	$25,295	$4,435	$12,705	$8,155	....
Miners' helpers—					
Average number	5	....	5	....	....
Wages	$5,445	....	$5,445	....	....
All other wage-earners—					
Average number	2	2	....	....	....
Wages	$1,219	$1,219	....	....	....
Average number of wage-earners at specified daily rates of pay:					
Machinists, blacksmiths, carpenters, and other mechanics—					
$2.00 to $2.24	1	....	....	1	....
$3.00 to $3.24	3	....	3	....	....
Miners or quarrymen—					
$1.00 to $1.24	5	....	....	....	5
$1.50 to $1.74	5	5	....	....	....
$1.75 to $1.99	8	1	....	7	....
$2.00 to $2.24	15	4	....	11	....
$2.25 to $2.49	5	....	....	5	....
$2.50 to $2.74	8	6	....	2	....
$2.75 to $2.99	4	....	4	....	....
$3.00 to $3.24	11	....	8	3	....
$3.50 to $3.74	8	1	2	....	5
$3.75 to $3.99	10	....	10	....	....
Miners' helpers—					
$3.00 to $3.24	5	....	5	....	....
All other wage-earners—					
$1.50 to $1.74	8	1	....	7	....
$2.00 to $2.24	3	....	....	....	3
$2.25 to $2.49	1	....	....	....	1
$2.50 to $2.74	1	1	....	....	....
$2.75 to $2.99	3	....	3	....	....
$3.00 to $3.24	4	....	4	....	....
Average number of wage-earners employed during each month:					
Men 16 years and over—					
January	92	30	11	40	11
February	90	27	12	40	11
March	87	23	13	40	11
April	112	18	41	42	11
May	109	16	51	31	11
June	141	17	82	31	11
July	140	17	81	32	11
August	120	8	69	32	11
September	118	15	61	31	11
October	94	17	26	34	17
November	99	25	12	36	26
December	94	15	9	44	26
Miscellaneous expenses:					
Total	$7,481	$1,568	$830	$1,900	$3,183
Royalties and rent of mine and mining plant	$437	....	....	....	$437
Rent of offices, taxes, insurance, interest, and other sundries	$7,044	$1,568	$830	$1,900	$2,746
Cost of supplies and materials	$17,781	$7,113	$5,920	$2,480	$2,268
Value of product	$328,450	$65,000	$115,000	$51,600	$96,850
Power owned:					
Total horsepower	150	25	75	....	50
Engines, steam—					
Number	4	1	1	....	2
Horsepower	150	25	75	....	50

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[1] Includes operators distributed as follows: Arkansas, 50; Arizona, 46 (1 mine); Colorado, 25; Idaho, 1; Maine, 13; Minnesota, 110; Nevada, 8 (1 mine); New Hampshire, 10; North Carolina, 18 (1 mine); Pennsylvania, 55; South Carolina, 5; South Dakota, 8; Virginia, 3; Wyoming, 3.

TALC AND SOAPSTONE

TALC AND SOAPSTONE.

By Joseph Hyde Pratt.

Talc and soapstone have assumed a very important place among the minor minerals, and in respect to the value of the production are near the head. This is due not so much to the variety of uses to which they are put as to the very remarkable growth in the utilization of talc in the manufacture of paper, for nearly two-thirds of the value of the production in 1902 was used for this purpose. Statistics for talc and soapstone include a small production of serpentine and the production of pyrophyllite, both of which are mined and used for the same purposes as those for which talc is employed.

In treating the statistics of the talc and soapstone mining industry it is necessary to include also the statistics of the manufacturing processes which are conducted at the mines under the same management, as the financial and other details are inseparable. This method has been customary since the census of 1860, which was the first census to give statistics for this industry.

Table 1.—*Comparative summary, 1860 to 1902.*

	1902	1890	1880	1870[1]	1860
Number of mines or quarries	20	(2)	14	(2)	(2)
Number of operators	20	(2)	(2)	[3] 9	[3] 4
Salaried officials, clerks, etc.:					
Number	75	(4)	(6)	(4)	(4)
Salaries	$63,713	(5)	(4)	(4)	(4)
Wage-earners:					
Average number	771	[6] 280	178	74	27
Wages	$279,083	$115,621	$57,545	$38,444	$10,824
Miscellaneous expenses	$80,136	(2)	(2)	(2)	(2)
Cost of supplies and materials	$125,932	$35,154	$18,203	$28,325	$10,425
Product:[7]					
Quantity, short tons	97,563	36,461	12,651	(2)	(2)
Value	$1,138,167	$475,878	$121,395	$189,115	$27,600

[1] Classification was "soapstone stoves, fireplaces, sinks, and cisterns."
[2] Not reported.
[3] Establishments.
[4] Not reported separately.
[5] Salaries included in wages.
[6] Foremen included in wage-earners.
[7] The United States Geological Survey reports 97,954 short tons valued at $1,140,507, which includes 391 short tons of soapstone, valued at $2,340 used as a mineral pigment and so reported by the Census.

The industry, as will be seen by the table, increased from a product in 1860 valued at $27,600 to one in 1902 valued at $1,138,167. From 1870 to 1880 there was a falling off in value of $67,720, although there were 5 more mines or establishments in operation and 104 more employees engaged in the work. This probably can be accounted for by the fact that a number of new properties were being opened and developed, and this development required a large increase in the number of employees without resulting in production for the current year.

Only the statistics for New York and North Carolina can be given separately, as there were not more than 2 producers in any of the other states. There were 20 mines in operation in the United States during 1902, of which 6 were in North Carolina; 4 in New York; 2 each in Maryland, Pennsylvania, and Virginia; and 1 each in California, Georgia, Massachusetts, and New Jersey. Thirteen mines were reported idle—1 each in California, Maryland, Massachusetts, North Carolina, and Ohio; 2 each in New Hampshire and Virginia; and 4 in Georgia.

Capital stock of incorporated companies.—Of the 20 mines reported, 13 were operated by incorporated companies, 4 by individuals, and 3 by firms. The details of the capital stock and funded debt authorized and issued by the 13 incorporated companies are shown in the following table:

Table 2.—*Capitalization of incorporated companies: 1902.*

	United States.	New York.	North Carolina.	All other states.[1]
Number of incorporated companies	13	4	5	4
Capital stock and bonds issued	$7,697,925	$6,119,500	$768,425	$810,000
Capital stock:				
Total authorized—				
Number of shares	98,877	61,300	13,377	24,200
Par value	$7,758,425	$6,130,000	$918,425	$710,000
Total issued—				
Number of shares	91,802	55,725	11,877	24,200
Par value	$7,050,925	$5,572,500	$768,425	$710,000
Dividends paid	$91,300	$67,300	....	$24,000
Common—				
Authorized—				
Number of shares	78,577	41,000	13,377	24,200
Par value	$5,728,425	$4,100,000	$918,425	$710,000
Issued—				
Number of shares	76,977	40,900	11,877	24,200
Par value	$5,568,425	$4,090,000	$768,425	$710,000
Dividends paid	$32,000	$8,000	....	$24,000
Preferred—				
Authorized—				
Number of shares	20,300	20,300	....	....
Par value	$2,030,000	$2,030,000	....	....
Issued—				
Number of shares	14,825	14,825	....	....
Par value	$1,482,500	$1,482,500	....	....
Dividends paid	$59,300	$59,300	....	....
Bonds:				
Authorized—				
Number	1,900	900	....	1,000
Par value	$730,000	$630,000	....	$100,000
Issued—				
Number	1,817	817	....	1,000
Par value	$647,000	$547,000	....	$100,000
Interest paid	$12,660	$6,660	....	$6,000

[1] Includes operators distributed as follows: California, 1; Pennsylvania, 1; Virginia, 2.

Five of the incorporated companies were in North Carolina, 4 in New York, 2 in Virginia, and 1 each in California and Pennsylvania. The capital stock and funded debt of the 4 New York companies constituted 79.5 per cent of the total. The par value of the capital stock issued was 90.9 per cent of the total par value authorized. The bonded indebtedness was 8.4 per cent of the capital stock and funded debt. The dividends paid amounted to 1.3 per cent of the total stock issued and 5.1 per cent of the total stock on which they were declared. Sixty-five per cent of the total amount paid in dividends was declared on preferred stock and 35 per cent on common. Of the total dividends 73.7 per cent was paid on the stock of the New York mines and 26.3 per cent on that of the mines in Virginia.

Employees and wages.—In considering the question of employees and wages, it is to be observed that the talc and soapstone industry is a composite one of mining and manufacturing. There are two principal kinds of manufacture: (1) The grinding of talc into flour, after which it is packed in bags preparatory to shipment, and (2) the sawing and finishing of soapstone into slabs, mantelpieces, laundry tubs, etc. Thus it can readily be seen that more employees are required, in proportion to the tonnage of the mineral mined, in an establishment where the higher grades of manufactured articles are made than in a plant where the mined talc is merely ground. This will explain the large number of employees in proportion to the tonnage in "all other states," because in these the soapstone mined is largely converted into manufactured articles, this being especially true of Virginia.

The number of salaried employees was 75, or 8.9 per cent of the aggregate average number of all employees, which was 846, and they received in salaries $63,713, or 18.6 per cent of the total salaries and wages, which amounted to $342,796. The number of wage-earners was 771, who received $279,083 in wages, which were 91.1 and 81.4 per cent, respectively, of the total number of employees and total wages. There were on an average 38.5 wage-earners to a mine. Of the states, the statistics of which are shown in detail, New York had 21.1 per cent of the wage-earners, and they received 30 per cent of the wages paid. North Carolina had 8 per cent, and they received 7.7 per cent of the wages.

Of the 771 wage-earners, only 98, or 12.7 per cent, worked below ground, the remaining 673, or 87.3 per cent, being employed above ground. Some of these, however, were employed in cleaning and preparing the talc and soapstone for market, while all the underground wage-earners were directly employed in mining the talc. Besides the number of wage-earners mentioned above, there were 9 foremen included among the salaried employees, who worked below ground.

Of the 771 wage-earners, 411, or 53.3 per cent, are classified as "miners or quarrymen and stonecutters:" of these 73, or 17.7 per cent, were employed in New York; 57, or 13.9 per cent, in North Carolina; and 281, or 68.4 per cent, in "all other states." In New York, 69 miners were employed underground and only 4 were reported as working above ground. In North Carolina, 8 miners were reported as working underground, and in "all other states" only 3 were so reported.

The daily rates of pay of the wage-earners, as given in Table 5, varied from 50 cents to $3.49 per day. Nearly one-half of the total number of all classes of wage-earners, or 46.8 per cent, received from $1 to $1.24 per day; 132, or 17.1 per cent, were paid from $1.25 to $1.49 per day. The highest rate of pay was received by those classified as "all other wage-earners," 16 of whom were paid from $3.25 to $3.49 per day, these being employed in the manufacture of the more intricate articles made from soapstone.

Of the 411 miners or quarrymen, 249, or 60.6 per cent, received only from $1 to $1.24 per day, this being due largely to the fact that most of these workmen were employed in the southern mines, where the rate of wages was much lower than it was for the same class of labor either in the North or East.

The average number of wage-earners employed during each month is also shown in Table 5. The busiest months for the industry were August, when an average of 826 employees were at work, and September, when the average reached 841. The month with the smallest average was November, with 705. In New York the greatest average number employed was 168, that number working in January and December. In North Carolina the greatest average was 85, employed in July, August, and September.

Supplies, materials, and miscellaneous expenses.—The amount, $125,932, reported as paid for supplies and materials was the principal item of expense, next to wages. Of the amount, $80,136, reported for miscellaneous expenses, $31,364, or 39.1 per cent, was expended for royalties and rent of mine and mining plant, and $48,772, or 60.9 per cent, for rent of offices, taxes, insurance, interest, and other sundries.

Mechanical power. Of the 20 operators, 16 reported primary power aggregating 3,945 horsepower. Of this, 2,700 horsepower, or 68.4 per cent, was supplied by water wheels; 1,235, or 31.3 per cent, by steam engines; and 10, or three-tenths of 1 per cent, by gas or gasoline engines. There were reported in addition 3 electric motors having a capacity of 225 horsepower. Of the 2,700 horsepower furnished by water wheels, 1,650, or 61.1 per cent, was used in New York; 630, or 23.3 per cent, in North Carolina; and 420, or 15.6 per cent, in "all other states." Of the 1,235 horsepower generated by steam, 530, or 42.9 per cent, was employed in New York; 70, or 5.7 per cent, in North Carolina; and 635, or 51.4 per cent, in "all other states." The 10 horsepower generated by gas or gasoline engines was used in California. The electric motors were reported from Virginia.

Production.—The total production of talc and soapstone in 1902 was 97,563 short tons, valued at $1,138,167, of which the state of New York, with 4 establishments, produced 71,100 tons, or 72.9 per cent, and North Carolina 5,238 tons, or 5.4 per cent, leaving 21,225 tons, or 21.7 per cent, for the 7 other states. In the value of the production New York is credited with 54.1 per cent of the total value, North Carolina with 7.8 per cent, and the 7 other states, collectively, with 38.1 per cent. In order to show the growth of the talc and soapstone industry in the United States since 1880, there is given in Table 3 the production of these minerals as reported by the United States Geological Survey since that year:

TABLE 3.—*Production of talc and soapstone: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (short tons).	Value.	Average value per ton.
1880	12,651	$121,895	$9.60
1881	12,000	135,000	11.25
1882	12,000	165,000	13.75
1883	14,000	225,000	16.07
1884	20,000	310,000	15.50
1885	20,000	310,000	15.50
1886	24,000	350,000	14.58
1887	27,000	385,000	14.26
1888	35,000	460,000	13.14
1889	36,461	475,878	13.05
1890	55,024	641,505	11.66
1891	69,568	737,049	10.59
1892	65,823	909,984	13.82
1893	56,932	658,503	11.57
1894	63,000	836,385	13.27
1895	60,725	637,392	10.49
1896	68,272	753,508	11.04
1897	78,932	762,565	9.66
1898	76,587	698,542	9.12
1899	79,120	768,955	9.68
1900	91,443	893,041	9.66
1901	97,843	908,488	9.29
1902	97,954	1,140,507	11.64

Since 1880 the average price per ton has ranged from $9.12 in 1898 to $16.07 in 1883. In 1902 the prices reported as received for the talc and soapstone products varied from $2.25 for material sold in the rough as quarried, to $31,025 received for manufactured articles. This wide variation in price is readily explained by the various uses to which talc and soapstone are put, and to the amount of work that is required in preparing the manufactured articles for market.

The imports of talc, 1880 to 1902, inclusive, principally from France and Italy, as published by the United States Geological Survey, are shown in the following table:

TABLE 4.—*Talc imported into the United States: 1880 to 1902.*

[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Quantity (short tons).	Value.	YEAR.	Quantity (short tons).	Value.
1880	(1)	$22,807	1892	531	$5,546
1881	(1)	7,331	1893	1,360	12,825
1882	(1)	25,641	1894	622	6,815
1883	(1)	14,607	1895	3,165	26,843
1884	(1)	41,165	1896	1,906	18,685
1885	(1)	24,356	1897	796	8,423
1886	(1)	24,514	1898	761	9,338
1887	(1)	49,250	1899	254	3,544
1888	24,165	22,446	1900	79	1,070
1889	19,229	30,993	1901	2,396	27,015
1890	1,044	1,560	1902	2,869	35,366
1891	81	1,121			

(1) Not reported.

The detailed statistics of the industry for 1902 are given in Table 5.

DESCRIPTIVE.

The name talc has been used very commonly, and yet erroneously, for a number of minerals which are similar to it in physical properties, but distinct mineralogically. Commercially, the name talc is usually applied to the fibrous and foliated varieties, which are the purer forms, and the name soapstone confined to the massive varieties. Mineralogically, the name talc refers not only to the foliated and fibrous varieties, but also to those which are compact, and soapstone or steatite is simply a variety of this mineral. Talc may be considered as occurring in the varieties, foliated and massive, with a third division known as fibrous talc, which is usually called pseudomorphous, as it has generally resulted from the alteration of the mineral enstatite. The foliated talc is the most valuable, being pure and very free from grit, so that it is suitable for use in the manufacture of talcum powders, etc. Occasionally this variety is so compact that it can be used in the manufacture of tailors' pencils, when it commands the highest price paid for any talc. Certain varieties of the massive talc are also pure enough to be ground into a flour talc, but the greater portion is used in the manufacture of soapstone articles.

The properties of talc (exclusive of soapstone) that make it suitable for the purposes for which it is used are its extreme softness, its purity or freedom from grit, its stability, and its smooth, slippery surface. Since the minerals serpentine and pyrophyllite closely approximate many of these properties, they are used to some extent for the same purposes. This is true especially of the latter, which can be used for many of the purposes for which flour talc is employed.

Occurrence.—Talc is found very commonly throughout many of the states, and in small quantities it is very widely distributed. The steatite variety occurs more frequently in commercial quantities, but it can be worked profitably only when it is located most favorably with regard to transportation facilities and in proximity to a market for the manufactured articles. In a number of states this variety is quarried and used for chimneys and fireplaces by the inhabitants of the district in which it occurs, but it is impossible to tell exactly how much is used in this way. It has been roughly estimated that in the mountains of North Carolina from 25 to 50 short tons per year are so used.

Large deposits of foliated talc have thus far been found only in North Carolina and New York, and in both cases they are associated with limestone. Small amounts of this variety of talc are found associated with the basic magnesian rocks extending from Alabama to Canada, but in no case has it been found in commercial quantity. Where, however, the pyroxenite variety of these basic magnesian rocks has been converted into the secondary rock composed almost entirely of the steatite variety of talc, it makes a deposit of commercial value if favorably located, as mentioned above.

Talc has been mined in California, Georgia, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Vermont, and Virginia. In 1902 it was mined in all these states except New Hampshire and Vermont. The California "talc product" that was put on the market in 1902 was not talc, but a variety of serpentine obtained from Santa Catalina Island, Los Angeles county. Recently, however, a deposit of talc was discovered in Tulare county, near Lindsay, about 2½ miles east of the railroad, where it occurs in lenses of from 6 to 8 feet in width and 100 or more feet in length. Since no good talc deposits are being worked on the Pacific coast, this deposit is worthy of investigation as to its commercial possibilities.

The deposits of Georgia and North Carolina are somewhat similar in their occurrence, and are probably parts of the same belt, although the Georgia talc is more compact and not so fine in quality. In Georgia the principal mining has been done in Murray county. At least one-half of the talc mined in this state is put on the market in the form of ground talc.

The deposits of North Carolina are found in Swain and Cherokee counties, and that portion of the belt in Swain county furnishes the most valuable talc that is produced in the United States, and in many respects is a unique occurrence of this mineral. The quality of this talc is such as is used in the manufacture of tailors' pencils, etc., and for which there is a larger demand than can be met. All the rest of the North Carolina talc is ground to flour, and most of it is used in the manufacture of toilet powders. In Moore county occur the pyrophyllite (soapstone) deposits, which have been mined quite extensively, the product being used for various purposes. None of it is as good quality as the genuine talc, nor does it command as high a price. For foundry purposes, however, as far as can be judged, it ought to be as satisfactory as the other.

The Massachusetts talc deposits are not very numerous, and the only one worked in 1902 was near Dalton, Berkshire county. The talc is of the foliated variety, and all that was mined was ground to flour talc.

The deposits of talc in Maryland and Virginia are of the steatite variety, and nearly all mined in these states is used for manufactured articles. A very small amount has been ground to a flour talc. A fibrous talc has been obtained in some quantity in the vicinity of Wiehle, Fairfax county, Virginia.

Soapstone deposits occur on both sides of the Delaware river, being found in Warren county, N. J., and in Northampton county, Pa., in the vicinity of Easton. The general width of this soapstone belt is from 500 to 600 feet, and the mineral is obtained usually by quarrying. Practically all of the Pennsylvania and New Jersey talc or soapstone is put on the market in the form of a ground product, most of which is used in the manufacture of paper.

St. Lawrence county, N. Y., is the scene of the largest talc industries in this country. The talc is of the fibrous variety, and is used almost entirely in the manufacture of paper. There are about twelve mines in this talc region, and they are located near Talcville, St. Lawrence county, and Littleyork, Cortland county. Since the consolidation of a number of the smaller properties the mining and manufacture of ground talc has been carried on more systematically and on a larger scale, thus increasing the production of talc in this state and decreasing the cost.

About 3 miles southeast of the village of Rochester, Vt., are old talc mines which were worked rather extensively during 1865–66. These are now being reopened and developed, and the material will be put on the market as ground talc.

There were no new deposits that produced talc during 1902, although some work was done in investigating deposits, most of the deposits investigated, however, proved to be of little or no commercial value, being for the most part of the steatite variety.

Methods of mining, manufacturing, and cleaning.—The mining of talc is either (1) by means of open cuts and pits, (2) by a system of shafts or tunnels and drifts, or (3) occasionally by a combination of both cuts and shafts. The mining of the soapstone (steatite) is largely by the first method. Mining by shafts, tunnels, and drifts is confined to the foliated and fibrous varieties of talc. In New York the method of mining is practically the same at all of the mines. Inclined shafts are sunk, following the dip of the country rock, which is first gneiss, and then massive white dolomite, as the beds of talc are approached. These rocks stand very well, so that timbering is required only occasionally. When the shafts reach the beds of talc, drifts are run along the strike of the deposit. On account of the compactness of this talc, blasting is usually necessary in removing it. As the talc comes from the mine it varies in size from particles no larger than dust to masses two feet or more in length, and it is conveyed in hand cars to the mills, where it is pulverized. The larger masses are broken with sledges and then passed through Blake crushers and conveyed by a belt to a pair of slightly corrugated steel rolls, which reduce the talc to small pieces, one-fourth inch or less in length. From the rolls the crushed talc is carried by an endless belt conveyor to bins on the top floors of the mills, and then it is conveyed automatically into Griffin mills on the floor below. A draft of air is forced through the mill, and as the talc becomes fairly fine it is blown through an opening and falls to the floor below. It is returned to the second floor and conveyed into large hopper shaped bin cars, from which it is dropped into Alsing cylinders, in which is a quantity of waterworn quartz pebbles, 2½ inches or less in diameter. As the cylinder revolves the constant pounding and rubbing of these quartz pebbles on the talc completely pulverize it. From this cylinder the talc passes through a grating, thus becoming separated from the quartz pebbles, and is conveyed automatically into a bag filling machine, where it is bagged and weighed, ready for shipment.

Talc mining in North Carolina does not present any serious difficulties, as the deposits do not extend to any great depth. The presence of water in the mines in the lowlands occasionally causes considerable expense and loss of time. Most of the mines thus located have been worked by means of open pits, which during a period of heavy rain have to be abandoned on account of being flooded. Although some of the deposits, especially those on the hillsides, can be worked advantageously by means of open pits, the majority of them are worked to the best advantage when shafts or tunnels and drifts are used. Little blasting is necessary at any of the mines, as the talc can usually be removed readily by pick and gad. As the rough blocks of talc are taken from the mine they are hand cobbed if necessary and sorted into three grades. The larger pieces are cleaned by rubbing them with steel brushes, and the smaller ones by a founder's scouring machine. They are then dried by being spread over a floor of steam pipes, which are kept at a temperature of 212° F. When these pieces are dry they are crushed and ground by means of crushers, rolls, and pulverizers, and the foreign material removed by screening. It is then further ground in buhrstone mills, similar to those used in grinding wheat, and passed through bolting cloth, which makes the final product nearly uniform in grain. This ground product is handled very much like flour, and in filling the bags with the flour talc, an ordinary flour packer is often used.

In Maryland, New Jersey, Pennsylvania, and Virginia, where it is principally the steatite variety of talc that is produced, the mining operations are carried on almost entirely in very large open cuts and pits. The preparation of the ground talc from the New Jersey and Pennsylvania mines or quarries is a process similar to that described above. In Virginia, where the soapstone is used almost exclusively for manufactured articles, the tonnage mined is of course very much larger than the weight of the articles manufactured and put on the market.

Uses.—Talc is employed in the arts in two distinct forms, as powder, or flour talc, and as pieces sawed into various sizes and shapes. The flour talc is now used as a base for fireproof paints, lubricants, and many of the cheaper soaps, for electric insulators, for boiler and steam pipe coverings, for foundry facings, for the dressing of skins and in the manufacture of dynamite, of the various toilet powders and of paper. Formerly certain varieties of clay were used as a filling in the manufacture of paper, but with the discovery of large deposits of talc, especially of the fibrous variety, in New York, talc has largely replaced them, its fibrous and pliable character giving additional strength as well as weight. The introduction of talc in the manufacture of toilet powders put on the market under the name of talcum powders gave a new use for the more valuable talc.

The soapstone, or steatite varieties of talc, are used for the most part in the manufacture of hearthstones, linings of furnaces, for cupola and converter linings in many steel works, for laboratory tables and ovens, for laundry tubs and slate pencils, and, to a limited extent, in building. It is also used quite extensively in the manufacture of soapstone griddles, foot warmers, boot driers, and for many other articles of everyday use.

TABLE 5.—DETAILED SUMMARY: 1902.

	United States.	New York.	North Carolina.	All other states.[1]
Number of mines or quarries	17	1	6	10
Number of operators	17	1	6	10
Character of ownership:				
Individual	4		1	3
Firm	3			3
Incorporated company	10	1	5	4
Salaried officials, clerks, etc.:				
Total number	75	29	12	34
Total salaries	$65,713	$19,664	$7,710	$38,339
General officers—				
Number	12	3	3	6
Salaries	$24,270	$2,260	$1,520	$20,490
Superintendents, managers, foremen, surveyors, etc.—				
Number	38	17	7	14
Salaries	$29,039	$12,160	$4,990	$11,889
Foremen below ground:				
Number	9	7		2
Salaries	$4,404	$4,144		$260
Clerks—				
Number	16	2	2	12
Salaries	$8,000	$1,100	$1,200	$5,700
Wage-earners:				
Aggregate average number	771	163	62	546
Aggregate wages	$278,783	$83,380	$21,416	$173,987
Above ground—				
Total average number	673	77	54	542
Total wages	$238,046	$46,278	$18,716	$173,052
Engineers, firemen, and other mechanics—				
Average number	282	13	5	264
Wages	$95,047	$7,860	$2,527	$84,660
Miners or quarrymen and stonecutters—				
Average number	331	4	49	278
Wages	$106,281	$1,700	$16,189	$88,392
All other wage-earners—				
Average number	60	60		
Wages	$36,718	$36,718		
Below ground:				
Total average number	98	86	8	4
Total wages	$40,737	$37,102	$2,700	$935
Miners—				
Average number	80	69	8	3
Wages	$32,202	$28,702	$2,700	$800
Miners' helpers—				
Average number	17	17		
Wages	$8,400	$8,400		
All other wage-earners—				
Average number	1			1
Wages	$135			$135
Average number of wage-earners at specified daily rates of pay:				
Engineers—				
$1.00 to $1.24	2		2	
$1.25 to $1.49	9			9
$1.50 to $1.74	4			4
$1.75 to $1.99	1	1		
$2.00 to $2.24	4	3		1
$2.25 to $2.49	1	1		
Firemen—				
$1.00 to $1.24	5			5
$1.25 to $1.49	2			2
$1.50 to $1.74	3	2	1	
Average number of wage-earners at specified daily rates of pay—Cont'd.				
Machinists, blacksmiths, carpenters, and other mechanics—				
$0.75 to $0.99	110			110
$1.00 to $1.24	105			105
$1.25 to $1.49	8			
$1.50 to $1.74	9	2		7
$1.75 to $1.99	4	1		3
$2.00 to $2.24	4	1	2	1
$2.50 to $2.74	4			4
$2.75 to $2.99	2			2
$3.00 to $3.24	1			1
Miners or quarrymen and stonecutters—				
$0.50 to $0.74	3		3	
$0.75 to $0.99	15		11	4
$1.00 to $1.24	249		15	234
$1.25 to $1.49	104	48	27	29
$1.50 to $1.74	33	22		11
$1.75 to $1.99	3	1	1	1
$2.00 to $2.24	3	1		2
Miners' helpers—				
$1.50 to $1.74	17	17		
All other wage-earners—				
$1.25 to $1.49	14	14		
$1.50 to $1.74	24	23		1
$1.75 to $1.99	2	2		
$2.00 to $2.24	3	3		
$2.75 to $2.99	2	2		
$3.25 to $3.49	16	16		
Average number of wage-earners employed during each month:				
January	766	168	48	550
February	717	163	48	506
March	769	161	48	560
April	783	162	54	567
May	813	164	63	586
June	764	163	65	536
July	791	156	85	550
August	826	164	85	577
September	841	166	85	590
October	766	164	65	537
November	705	157	50	498
December	711	168	48	495
Miscellaneous expenses:				
Total	$80,136	$38,786	$27,981	$13,369
Royalties and rent of mine and mining plant	$31,364	$28,226	$720	$2,418
Rent of offices, taxes, insurance, interest, and other sundries	$48,772	$10,560	$27,261	$10,951
Cost of supplies and materials	$125,932	$15,253	$12,447	$98,232
Product:				
Quantity, short tons	97,563	71,100	5,238	21,225
Value	$1,138,167	$615,350	$88,962	$433,855
Power owned:				
Total horsepower	3,945	2,180	700	1,065
Engines—				
Steam—				
Number	12	3	2	7
Horsepower	1,235	530	70	635
Gas or gasoline—				
Number	1			1
Horsepower	10			10
Water wheels—				
Number	33	21	6	6
Horsepower	2,700	1,650	630	420
Electric motors—				
Number	3			3
Horsepower	225			225

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[1] Includes operators distributed as follows: California, 1; Georgia, 1; Maryland, 2; Massachusetts, 1; New Jersey, 1; Pennsylvania, 2; and Virginia, 2.

MAGNESITE

MAGNESITE.

By Joseph Struthers, Ph. D.

The output of magnesite in the United States is obtained solely from California. The mineral occurs in other states, but the deposits are not of sufficient extent or purity to render their exploitation a commercial possibility. The deposits of this mineral occur in several localities in California, but a mine located in Tulare county was the only one in active operation during 1902. It is impossible, therefore, without disclosing individual operations, to publish the complete statistics for this branch of the mining industry, and they are included in the group of "all other minerals" in the general tables. Of the magnesite mines which were idle during 1902, 2 are located in Alameda county, 2 in Napa county, and 1 each in Santa Clara, Sonoma, and Stanislaus counties, a total of 7. The mineral has also been found in San Bernardino county.

Production.—During 1902 the production of magnesite in California amounted to 3,086 short tons of crude ore. Of this product 2,236 short tons were calcined, the result being 1,050 short tons of the calcined product, valued at $15,780. The remaining 850 short tons of crude ore were valued at $3,859. The value of the entire product was therefore $19,639.

The quantity and value of crude magnesite marketed in the United States during the years 1891 to 1902, inclusive, including the value of the calcined product, is given in the following table from the report of the United States Geological Survey:

Table I.—*Production of magnesite 1891 to 1902.*

[United States Geological Survey "Mineral Resources of the United States," 1902.]

YEAR	Quantity (short tons).	Value.
1891	439	$4,390
1892	1,004	10,040
1893	704	7,040
1894	1,440	10,240
1895	2,220	17,000
1896	1,500	11,000
1897	1,143	13,671
1898	1,263	19,075
1899	1,280	18,480
1900	2,252	19,333
1901	13,172	43,057
1902	3,466	21,362

The census figures for 1902, as given in the text, are for the quantity mined that year, while those of the Survey include 380 tons, valued at $1,723, mined previously but sold in 1902.

The production of crude magnesite is practically under the control of one firm in California, which ships much of the output to two manufacturers of carbon dioxide gas for use in the production of the gas by calcination. The calcined product, essentially magnesium oxide, or magnesia, is returned to the shipper and is subsequently utilized by paper mills in California and Oregon. The demand for calcined magnesite for this purpose in the West is limited, and only a small portion of the available supply is utilized—a trade condition which is reflected by the different unit value of the calcined product from year to year when considered in connection with the quantities produced. Thus in 1900 the supply of calcined magnesite amounted to 1,013 short tons, and the average value per ton was $15.70; in 1901 the output, 4,726 short tons, far exceeded the demand, and the average value decreased to $5.57 per ton; in 1902 the quantity produced, 1,050 short tons, was again just sufficient to satisfy the normal consumption, and the average value per ton rose to $15.03.

Consumption.—It is impracticable to furnish accurate statistics of the consumption of magnesite and of magnesite products in the United States, owing to the fact that in the official reports no distinction is made between the imports of crude and of calcined magnesite; furthermore, the statistics of the quantity and value of imported magnesite bricks are not separately reported. During 1902 the imports of crude and calcined magnesite (which were chiefly from Greece and Austria) amounted to 49,786 short tons, valued at $373,928, as compared with 33,461 short tons in 1901. There was also a very large importation of magnesite bricks, but no statistics of their quantity or value are available. By adding the figures for imports to the figures for the marketed production, as given by the Geological Survey, an estimate may, however, be made of the consumption exclusive of the quantity contained in brick form; on this basis the quantity of crude and calcined magnesite consumed in the United States during 1902 was 53,252 short tons, as compared with 46,633 short tons in 1901 and 31,076 short tons in 1900. These statistics show the increasing importance of magnesite in the industrial arts in the United States; they also show that only a very small fraction of the supply is of domestic origin.

The industry in the United States.—Magnesite is found in many localities in the United States—in California and in Massachusetts; at Bare Hill, near Baltimore, Md.; near Rye and at Stonypoint, N. Y.; near Hoboken, N. J.; in Yancey and Cabarrus counties, N. C.; in Chester and Lancaster counties, Pa.; in Arizona and in Texas. But the deposits have been worked with commercial success only in the first-named state. The deposits in California are quite widespread, occurring in the following counties: Alameda, Colusa, Fresno, Kern, Mariposa, Monterey, Napa, Placer, San Luis Obispo, Santa Clara, Stanislaus, Tulare, and Tuolumne. The only producing property during the year was in Tulare county, near Portersville, where the mineral occurs in a series of vertical and flat veins, in some cases 10 feet in width, and has wall rocks of serpentine and granite. Some of these veins outcrop boldly, and a few of them have been traced on the surface for several thousand feet. A large quantity of mineral has been disclosed by open cuts and a tunnel. A 10-ton kiln, using crude petroleum as fuel, serves to calcine the product, which is then shipped to paper mills, and a second kiln will be erected as soon as the demand warrants it. The calcining treatment, which is carried on at a temperature of 2,500° F., occupies from three to three and one-half hours; the carbon dioxide gas expelled is allowed to escape into the air. In the calcination of magnesite, 48 to 52 per cent of its weight is lost by the expulsion of the carbon dioxide. The cost of the calcined product at the kiln is from $12 to $14 per ton. The demand for magnesite has increased rapidly east of the Rocky mountains; but owing to the high cost of transportation from the Pacific coast, most of the mineral used is imported, mainly from Greece. An important problem of the industry in California is to reduce the cost of calcination to a point which will admit of the shipment of the calcined product to Pittsburg, where it might be used for the manufacture of magnesite brick and other refractory products, an industry in which at present magnesite imported from the island of Euboea, in Greece, and from Styria, in Austria, is used. Another important feature is the development of the iron and steel industry on the Pacific coast, which will give a strong impetus to the mining of magnesite and its manufacture into bricks and concrete for use as a basic lining of furnaces or converters, for treating phosphoric pig iron to make basic open-hearth or basic Bessemer steel.

The industry in foreign countries.—The greater portion of the world's production of magnesite at the present time comes from the deposits in Austria and Greece. During 1901 the exports of calcined magnesite from Austria amounted to 40,236 metric tons, valued at $321,800. The deposits in Austria have attained their greatest development near Vietsch. The formation is of the Silurian age and consists of argillaceous shales, quartzite, dolomite, and gneiss. The magnesite occurs in beds conformable with the strata and is usually seamed with calcite, dolomite, and quartz, with occasionally segregations of dolomite crystals; it is necessary, therefore, to cob and pick the mineral. The sorted ore, which usually contains from 90 to 96 per cent of magnesium carbonate, is calcined at a white heat in kilns lined with magnesite bricks at those sections where the temperature is the highest, in order to prevent the introduction of impurities into the material. The small amounts of silica and ferric oxide contained in the ore are sufficient only to sinter it. The kilns are continuous in action and yield 80 tons of calcined ore daily. This product is sorted mechanically for the removal of the fine dust, as well as quartz and other impurities, that may not have been separated in the preliminary cobbing process. The sorted calcined material is then crushed, formed into bricks in steel molds by hydraulic pressure of about 4,500 pounds per square inch, and finally burned in kilns at a high temperature, thus producing the solid and compact magnesite brick as it appears in the trade.

In Greece the magnesite mines are near Mantudi and Limni in the northern part of the island of Euboea. The mineral is in crypto-crystalline form and occurs in large veins in serpentine; picked samples contain as high as 98 per cent of magnesium carbonate, but the average composition approximates 95 per cent. Formerly the sorted ore was calcined in kilns fired by wood, but this process has been cheapened by the introduction of modern shaft calciners using a local lignite for fuel. Ordinarily the completely calcined ore falls to powder when moved and causes the lower and cooler portion of the ordinary kiln to become choked with fine material, thereby preventing the access of air which is necessary for the combustion of the fuel. The modern furnace is constructed especially to overcome this defect. The magnesite from Euboea is exceptionally pure and on account of the absence of impurities, it sinters only at a very high temperature. As this magnesite is so highly refractory, it is necessary in the manufacture of bricks to add a suitable binding material. At the brickworks at Mantudi, a small proportion of serpentine is added to the mixture which is molded and burned at a temperature of 1,400° C. in a regenerative furnace of the Siemens type, yielding a very hard and dense brick.

Deposits of magnesite have been found at Sutton and Bolton, Ontario, Canada; near Frankenstein, Germany; in the Department of Ufa, southern Urals, Russia; in India; and at several localities in Hungary. A few of these deposits have been worked, but the output from them at the present time is very small, when compared with the total production of the world.

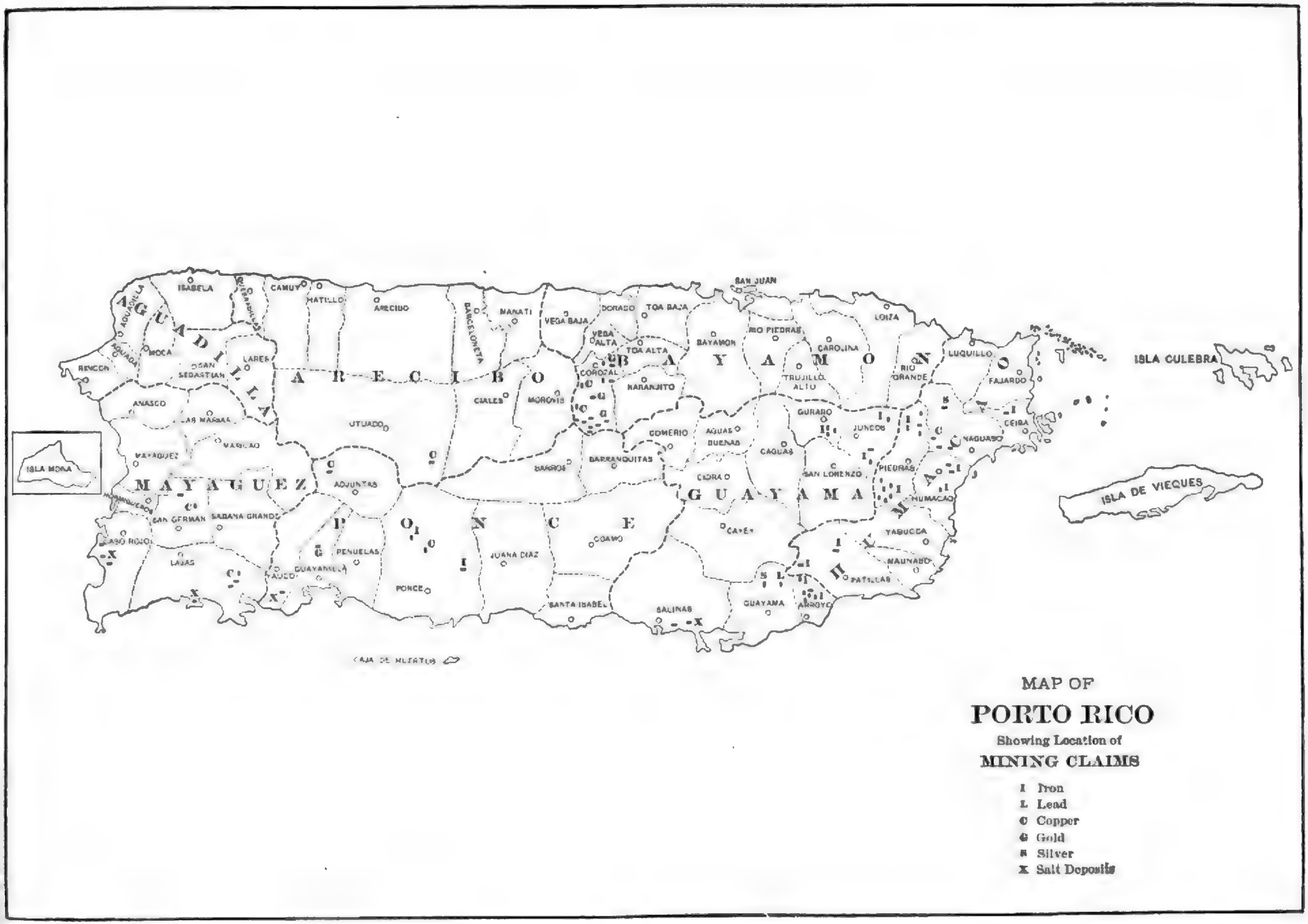
Occurrence and characteristics.—Magnesite, magnesium carbonate ($MgCO_3$), corresponds chemically to calcite, calcium carbonate ($CaCO_3$). In the pure state, it contains 47.6 per cent of magnesium oxide, and 52.4 per cent of carbon dioxide. When impure, magnesium silicate is present and at times iron oxide. Pure magnesite occurs in transparent, rhombohedral crystals; in the massive form it is compact and granular, resembling unglazed porcelain in appearance. In color it is generally white, but often of a yellowish, grayish, or even brownish tinge. The brownish color is imparted to the mineral by the impurity, iron oxide, which if present to the extent of several per cent forms the variety "breunnerite," or "brown spar," as it is sometimes called. In hardness magnesite varies from 3.5 to 4.5, and though brittle, it is exceedingly difficult to drill. Its specific gravity varies from 3 to 3.12.

The formation of magnesite, which is usually associated with serpentine, is attributed to the action of carbonated waters upon eruptive magnesium rocks, such as olivine (chrysolite); when this action has been carried nearer to completion, the serpentine also is decomposed, yielding as final products magnesite and quartz. While magnesite generally occurs associated with serpentine, it is found also with other magnesian minerals, as talc, brucite, dolomite, etc. It is sometimes found in gypsum, and when the veins are irregularly mixed with the gypsum the mass forms the variety of marble known as "verd antique."

Uses. In the crude condition magnesite is used largely for making carbon dioxide gas, either by the application of heat alone or by treatment with sulphuric acid. The carbon dioxide so produced is utilized largely either in the gaseous or liquefied state to "charge" or carbonate mineral waters and other beverages, and its use in mechanical refrigeration in warm countries and on shipboard is increasing. When crude magnesite is decomposed by sulphuric acid, magnesium sulphate is obtained as a by-product, which, being dissolved in water, filtered, and crystallized, yields Epsom salts ($MgSO_4 . 7H_2O$). During 1902 it is estimated that at least 17,500,000 pounds of this salt were produced in the United States. At least 90 per cent of the domestic output of Epsom salts produced during 1902 was consumed in the manufacture of dyes, laundry soaps, and paints, and in tanning leather; the remaining 10 per cent was used in the preparation of medicinal salts. Early in 1903 a combination was effected of the various concerns engaged in making Epsom salts in the United States. Crude magnesite is used to a minor extent in the manufacture of the magnesia alba of pharmacy. This preparation is a mixture of magnesium carbonate and hydrate.

The consumption of magnesite in its calcined state (which corresponds to magnesia, MgO) has increased very largely since 1899, owing to its uses in the form of bricks or concrete as a refractory lining for open-hearth furnaces and Bessemer converters in the steel industry, and for special parts of furnaces used in the smelting of copper and lead ores; as a lining for rotary kilns used in the manufacture of Portland cement; as a nonconducting covering for boilers, steam pipes, etc., to prevent loss of heat; and more recently in electric furnace construction as a refractory material. It is used also in the manufacture of paper stock by the sulphite process, the wood pulp being digested under pressure in calcium-magnesium acid sulphite, whereby the lignin which forms the coloring matter of the wood, as well as other incrusting material of the fiber, is converted into soluble products, which are subsequently removed by washing. The general adoption of the basic process of making steel has also largely increased the use of magnesite for furnace linings, especially in the form of bricks.

MINERAL INDUSTRIES OF PORTO RICO



MAP OF

PORTO RICO

Showing Location of

MINING CLAIMS

MINERAL INDUSTRIES OF PORTO RICO.

By William F. Willoughby.

The investigation of the mineral industries of Porto Rico for the year ending December 31, 1902, report of which is given in the pages that follow, representing, as it did, the first attempt to present a comprehensive exhibit of the character and importance of the mineral resources of the island and of their exploitation, had to contend with the difficulties usually attendant upon initial statistical or census work in any field. These difficulties consisted not so much in securing data concerning mineral deposits and their working, after their existence was known, as in securing information concerning such existence and working itself. In the present case this difficulty was especially acute owing to the lack of official data and the fact that in no case were mining operations being conducted as a regular industrial enterprise. Such work as was done during the year was almost wholly of a prospecting and experimental character. Even brickmaking and stone quarrying were carried on in an intermittent manner, bricks being made as demand arose for them and quarries being worked here and there by contractors in need of material for roadmaking.

In view of these conditions it was deemed that the most important work that could be done by the investigation would consist of presenting (1) such historical data as could be obtained regarding the search for, and discovery of, minerals in the past, and efforts that had been made for their utilization; (2) a statement of the laws in force regarding the location and exploitation of mining claims; (3) a list of all mineral deposits of which information could be secured by making the most thorough investigation possible; and (4) an account, with such statistical data as could be obtained, of work actually done during the year in the utilization or manipulation of such mineral resources.

In these efforts it is believed that, thanks to the cooperation of the different insular and local officials, a large measure of success has been attained. The thoroughness of the canvass may be seen from the following statement of the means employed in securing information. In addition to the personal researches of the author and his assistants, information was sought and secured from each of the sixty collectors and deputy collectors of taxes attached to the Treasury Department of the island, whose duties are such as to make them personally acquainted with every important taxpayer or industrial enterprise in their respective districts, from the twenty-odd internal revenue agents whose duties take them to every part of the island, no matter how difficult of access, and finally from all the contractors and superintendents engaged in the construction or maintenance of the highways. The commissioner of the district of Porto Rico and the chief of the Bureau of Mines under his jurisdiction likewise rendered every possible assistance in the way of furnishing data taken from official records and in directing all of their employees to furnish any information in their power.

Mining, as generally understood in the United States, has not up to the present time been a stable industry in Porto Rico. Certain minerals were known to exist by Ponce de Leon and his followers in the early part of the sixteenth century, but no systematic or scientific methods were then, or have been since, employed in their extraction. The absence of any relics pertaining to the period antedating the discovery of the island by the Spaniards would tend to show that metals were not used in the manufacture of warlike implements or domestic utensils, neither has there been unearthed any metal adornments, such as anklets, arm rings, or similar decorations with which primitive tribes conversant with the use of metals were wont to adorn their women folk. The complete absence also of shafts, tunnels, and other evidences of ore mining, such as are being constantly uncovered in other Spanish-American countries, would further tend to confirm the opinion that neither the Borinqueños nor their Spanish conquerors practiced mining except in a desultory manner, and the lack of historical mention of such industry likewise strengthens this belief. Fray Iñigo Abad, in his "History of Porto Rico" (1788), makes reference to early remittances of gold to the Spanish peninsula, but all the gold extracted was undoubtedly obtained from river washings by enforced native labor. In his description of the effects of the great hurricane of 1530 the same historian says: "Se volvian los ojos á las minas, las veian todas sumergidas por las crecientes de los rios" (They turned their eyes to the mines, but found them all submerged by the overflow of the rivers).

Official or other reliable data relative to the geological formation of the island is also practically nonexistent. Some attempt to compile a report on the subject was made by Angel Vasconi, a Spanish engineer, and the result of his labors was laid before the directors of the Exposition of Mineralogy held at Madrid in 1883. The monograph comprising the report is not extant in Porto Rico, but a portion of the rough draft was found among the archives of the insular Bureau of Mines by its present chief and was largely drawn upon by the Governor of Porto Rico in his second annual report to the President of the United States. The information therein contained is considered worthy of reproduction as presenting in succinct and precise form what little is known of the mineral bearing formations which go to make up the soil and subsoil of this new possession of the United States.

[Extract from the second annual report of the Governor of Porto Rico to the President of the United States.]

Gold placers were worked for some years by the Spaniards in the first century of the conquest, and, according to official statistics, 2,700 pounds of gold were sent to Spain from the year 1509 to the year 1536. It is believed that that figure only represents the part belonging to the Crown of Spain—that is to say, the fifth of the total production during that period of time.

The Sierra de Luquillo, the more abrupt and the highest of all the mountains in Porto Rico, belongs to the main cordillera, or chain, which cuts the island from east to west, with a prolongation to the Windward Islands, by the east, and to the little island of Desecheo, situated opposite to Mayaguez and Añasco, by the west. That mountain, or sierra, is in the northeastern part of the island, and owing to its situation and the elevation of its hills—the highest being El Yunque, 1,200 meters [3,937 feet] above sea level—is the first vessels can distinguish in coming to Porto Rico. From El Yunque and the hills named Cuchilla Firme, Meseta, Peña Parada, and others, various rivers flow in which gold has been found. The Mameyes, one of the richer in gold, has as tributaries the rivulets known as Filipina, Cajones, Guaraguao, La Mina, La Máquina, Tabonuco, and Anon. In this last named, the Anon, some thirty-eight years ago, a rich concern did some work in the washing of sands or auriferous alluvia, obtaining from one to two pounds of fine gold per day. The rocks more abundantly found in the watershed of Mameyes River are eurite and porphyry, crossed with veins of quartz and iron pyrites. The alluvial lands occupy a good extension of the middle and lower parts of these watersheds, and are composed of clay, sand, and bowlders, forming deposits of analogous nature. Their depth is variable. In the valley of the Anon there are some cuts, from six to eight meters (20 to 26 feet) deep, made in such alluvial deposits with the view of exploiting the auriferous strata.

It is known that the watershed of the rivers Corozal, Negros, Congos, Cibuco, Mavilla, and Manatí contain auriferous sands. The idea which occurs to one examining the vicinity of Corozal is that that valley was emptied, through a process of erosion, by the diluvial waters, which produced in the calcareous soil cuts more than 130 meters [427 feet] deep, through which ran a stream. It is believed that the waters of that stream deposited the quaternary alluvia. The calcareous soil, said to be of the Tertiary formation, occupies the right shore of the river and extends itself by the north toward the sea. On the left shore, and in the bed of the river, the limestone has disappeared, giving place to potent strata of sandstone, on which the auriferous quaternary alluvia lay. The alluvial deposits are more potent the lower they are, and gold is found very near the surface in the higher and hilly parts, while, on the contrary, in the great deposits of the lower parts of the valley the auriferous strata are covered by sterile masses. Near the source of the Congos River, in the bed of it, and 25 centimeters (9.8 inches) deep, some pieces of quartz have been found containing from 8 to 10 grams [123 to 154 grains] of pure gold. In the jurisdiction of Corozal some washing machinery was established, and the result was from $2.17 to $4.30 for each ton of sand.

There are also, according to official information, some gold placers in Mayaguez, San German, Yauco, and Coamo. The gold is found in grains or nuggets of $2 or $3 value, and, rarely, nuggets of even higher value. In the Fajardo River a piece was found which weighed 4 ounces, and in the Congos another piece of 1 pound was also found; but the biggest piece of pure native gold was discovered in the lands belonging to Mr. Bou, in the jurisdiction of Corozal. That piece was sold to Mr. Bou by the finder for $200 in money and some other valuable things. In the bed of the Filipina rivulet there were obtained from 60 kilograms [132 pounds] of sand six-tenths of a gram [9 grains] of pure gold, which makes 10 grams [154 grains] for 1 ton of sand. The enterprises mentioned were abandoned, and the only work on the mines was done by the "lavadores," washmen. They use an instrument called "gaveta," made of wood, shaped like a plate, of 40 centimeters [16 inches] in diameter and 12 centimeters [5 inches] deep. In the watersheds of Mameyes River and in all the rivers crossing the jurisdiction of Corozal numbers of peasants can be seen engaged in the work of washing auriferous sand, from which they obtain gold in amount sufficient to pay for their support.

Since the American occupation, work on the mines has had renewed life, and the number of applications for mining concessions filed in the Bureau of Agriculture and Mines has increased. Up to July concessions have been granted for 107 hectares (264 acres) of land.

The minerals of copper obtained are: Ferriferous motley copper, native copper, green and blue carbonates, yellow copper sulphide, often accompanied with iron pyrites and iron oxides. Spanish explorers of the island paid little or no attention to copper. It is generally found along the main chain of mountains dividing the island from east to west, from the neighboring island of Viesques, and then following through Rio Blanco, Gurabo, Corozal, Ciales, Jayuya, Maricao, and some other places which belong to the southern chain of mountains, such as Las Piedras, Humacao, Ponce, Piñalejo, and also in the vicinity of the road from Caguas to San Juan, the richest place being the barrio of Rio Blanco, in the municipality of Naguabo. The first works for the exploitation of copper began in 1869. In the mine named "La Abundancia" some small excavations were made, and the superficial carbonate was gathered, and many tons of rich mineral were thus obtained. Like results were reached in the mines named Santa Amalia, La Castellana, and Santa Teresa, all located in the barrio of Rio Blanco. In the last-named mine copper indications were noted from the surface to a depth of 25 meters [82 feet], first as green carbonate with 23 per cent of copper, then as ferriferous motley copper, and, in some parts, yellow sulphide, very pure. In 1879, 10 tons of copper sulphide were obtained from the mine Santa Teresa, and 60 tons of carbonate of copper from the Santa Amalia. Owing to the difficulties and high prices of transportation, work ceased.

The existence of silver in the island has been officially recognized. On July 19, 1538, the "oficiales reales" wrote to the King of Spain that "veins of lead containing some silver have been found," and on March 29 of the following year they wrote, "With respect to the silver mines here discovered we arranged that that mineral be fused here, but there is no person who knows how to do it. In some places veins of that metal have been found, but nothing has been done, waiting the arrival of some one who knows how to fuse

> and work it." In the History of Porto Rico, by Fray Iñigo Abad, with notes by Don José Julian Acosta, the statement is made that in the Serrania de Añasco there was a mine containing silver; and, in a report prepared in 1879 by the chief engineer of the bureau of mines, reference is made to certain samples of silver found in the barrio Llamos, of the municipality of Isabela. In other official documents the existence of silver in the northwestern part of the island is affirmed. Concessions have been made of silver mines in Naguabo, Corozal, Rio Grande, Fajardo, Lajas, and Las Piedras.
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> In the subsoil of the eastern part of the island there is feldspathic rock. This section is confined on the north by the Sierra de Luquillo, and on the south by the Pandura, parallel ranges of hills, and distant one from the other from 25 to 30 kilometers (16 to 19 miles). It is stated that the surface lodes occupy a large area, the depth not having been determined as yet. Iron is found, according to tests made, at the rate of 61 per cent of the mineral. Iron of excellent quality has been found in the barrios Mameyes and Jayuya, municipality of Utuado, and in Luquillo, Piedras, Naguabo, Humacao, Gurabo, Patillas, San Lorenzo, and Arroyo. The concessions of iron mines are numerous. Some efforts are being made now with the view of organizing enterprises for the exploitation of iron in the eastern part of the island.
>
> There are in the island, according to official information, some deposits of lead minerals. Good samples of galena have been found in Arroyo, Mayaguez, and Naranjito. There are two concessions granted in the municipality of Guayama, one being for the exploitation of lead and the other for argentiferous galena. Minerals containing some amount of peroxide of manganese have been gathered in the vicinity of Corozal. Native bismuth has been discovered in Ponce. Samples of platinum, tin, and mercury have been obtained in the jurisdiction of Corozal.

All other official reports touch but lightly on the mineral resources of the island and do not convey any information not embodied in the foregoing extract. Mr. Robert T. Hill, of the United States Geological Survey, in his accurate and interesting work entitled "Cuba and Porto Rico," devotes but ten lines to the subject, saying:

> A little placer gold is found in the rivers of the Sierra Luquillo and Corozal, and mercury in the Rio Grande. Gold was formerly mined by the early Spanish settlers and is still taken out in small quantities by the natives. Molybdena, magnetic pyrite, manganite, limonite, chrysocolla, epidote, and garnet are the minor minerals found. Specular iron is reported in several places, notably in the river Cuyul. Magnetic iron is also reported from Gurabo and Ciales. Crystals of quartz are found in the Rio Prieto, agate of good quality at Caja de Muertos, and malachite at Rio Blanco.

MINING LAWS.

Notwithstanding the absence of anything approaching an organized mining industry in Porto Rico there is, nevertheless, a complete system of laws and regulations governing the right to exploit both precious and base metals in the island.

This is substantially contained in the law of July 6, 1859, and the ministerial order of December 29, 1868, enacted originally for application in the Spanish peninsula only, but subsequently extended to Porto Rico by the law of May 3, 1895. Many of the provisions of these statutes have by reason of the change of sovereignty become inapplicable, and it is understood that a new mining law is being drafted and will be presented at the next session of the insular legislature. In so far as possible, however, the principles and procedure of the existing laws are being observed, and deficiencies arising from changed political conditions treated by analogy.

Minerals subject to mining claims are divided by the law into three classes, as follows:

Class I: Minerals of an earthy nature, minerals of a siliceous nature, slates, minerals of a sandy nature, granites, basalts, limestones, gypsums, sands, marls, clayey earths, construction materials in quarry formation.

Class II: Placers, metallic sands or alluvia, bogs, emery, ochers and almagras, scoria and mineral tailings, peats, pyritic earths, aluminous earths, magnesium earths, salt deposits, lime phosphates, barytes, fluorspars, steatites, ravolins, clays.

Class III: Metallic veins, anthracites, pit coals, lignites, asphalts, bitumens, petroleum and mineral oils, graphites, saline substances, including alkaline and terraceous salts, either solid or in solution, copperas, sulphur, precious stones, iron ores.

In order to obtain legal title to a mining claim the claimant must submit a petition to the Commissioner of the Interior of Porto Rico setting forth the area of the desired claim, the class of mineral to be worked, and the name of the owner of the property wherein the claim is situated. He must also furnish a survey of the claim and, within ten days from date of filing his petition, must deposit the sum of $36 if the claim does not exceed in area 12 pertenencias (30 acres), and $1.20 for each additional pertenencia. No claim can be filed for less than 4 pertenencias, but there is no limit to the number of pertenencias that may be included in one claim. Each pertenencia must, however, be contiguous along the whole of one of its sides to some other pertenencia of the same claim, and must consist of a regular square, each side measuring 100 meters (328 feet). The aforesaid deposit is to cover the expense of an official survey made later by the Government. The first conditions being complied with, the petition is advertised for sixty days to enable protests to be filed, which protests are submitted to the claimant for reply within twenty days. The complete brief is then passed upon by the Commissioner of the Interior of Porto Rico, and his decision, if favorable to the claimant, is followed by the appointment of a surveyor to lay out the claim and the payment of a further fee by the claimant, amounting to 60 cents per pertenencia (2½ acres), to cover expenses of title. A title signed by the Governor is then issued, and is valid forever, subject to an annual rental (canon de minas) of $2.40 per pertenencia for precious metals, or 96 cents per pertenencia for base metals. This title does not carry any obligation to work the mine, and lapses only on failure to pay the annual rental.

Pending legislation relative to the disposition of public lands (terrenos baldios), no mining claims are being allowed on public property.

PRECIOUS METALS.

There are at present twenty mining claims registered on the books of the Bureau of Mines, none of which, however, is in operation.

Registered mining claims of precious metals.

NAME OF OWNER.	Name of mine.	LOCATION OF MINE.			AREA OF MINE—		Class of mineral said to exist.
		Department.	Municipal district.	Ward.	In hectares.	In acres.	
Henry D. Sayre	San Luis	Bayamon	Corozal	Negros	18	44	Gold.
Do	O'Reylly	do	do	Padilla	25	62	Gold and other.
Do	Sayre	do	do	Palos Blancos	14	35	Do.
Josef Zervas	Augusta	Ponce	Guayanilla	Pasto	24	59	Do.
Wm. B. Crawford	La Palma	Bayamon	Toa Alta	Palmarejo	12	30	Do.
Henry D. Sayre	Rachel	do	Corozal	Cuchillas	32	79	Do.
Do	Lena	do	do	Negros	12	30	Do.
Do	Henry	do	do	Cuchillas	35	86	Do.
Do	The World	do	do	Palos Blancos	148	366	Do.
Do	Huyler	do	do	Cuchillas	12	30	Do.
Do	Dunham	do	do	do	12	30	Do.
Do	Mate	do	do	Negros	12	30	Do.
M. Lancaster	Palmarejo	do	do	Palmarejo	24	59	Do.
D. McLean	Florine	do	do	Palos Blancos	25	62	Do.
Do	Edwin	do	do	Dos Bocas	12	30	Do.
Henry D. Sayre	Ethel	do	do	do	17	42	Do.
C. Bernstein	Catinesterida	Humacao	Luquillo	Mameyes	12	30	Auriferous sand.
Argueso & Miner	Ernestita	do	Naguabo	Rio Blanco	100	247	Silver and nickel.
D. McLean	Vanderbilt	Bayamon	Corozal	Dos Bocas	12	30	Silver and other.
Hogan & Pierce	Reina del Cobre	do	do	do	12	30	Do.

All of these claims have been filed since the American occupation of the island, and some little exploration work has been done in the case of a few of the claims situated in the Corozal district. The owners of each of the above-enumerated claims have been interrogated by letter as to whether their respective claims were in operation, but except from the owners of two of these claims (Augusta and La Palma) no response has been elicited. The owners of the other mines are not to be found at present in the island. It may, therefore, truthfully be said that ore mining of precious metals is entirely prospective and confined to the filing and registration of the above-mentioned claims, none of which is being exploited.

PLACER GOLD MINING.

Such gold mining as is actually engaged in at present in Porto Rico is entirely of the placer type, unimportant in scope and confined to the Corozal district of the island. There are some twenty or more miners of the peon class engaged steadily in the work of extracting gold from the sands of the river by means of an oscillating movement of the hands applied to a wooden disk in which the sands are washed. From the best information obtainable, the value of the gold thus secured daily will aggregate, approximately, $25. It is understood that Mr. Henry D. Sayre, who is the *concessionaire* of eleven mining claims in the Corozal district, intends shortly to operate on an extensive scale. Mr. Sayre is an experienced miner, who has invested a considerable sum of money in exploration, surveys, and assays in Porto Rico, and is said to be very favorably impressed with the mineral wealth of the Corozal district. He has recently applied to the executive council of Porto Rico for a franchise authorizing him to divert the waters of the Mabille river from their natural course with a view to obtaining the deposits of gold in the river bed. Whether any attempt at ore mining will be made by Mr. Sayre is not at present known, but it is understood that he claims to have discovered the original veins from which the deposits in the river bed are derived. Although there is evidence of placer mining having been practiced in other parts of the island as well as in the Corozal district, particularly in the vicinity of San German, no mining for gold is at present carried on outside of the Corozal region. This failure to operate elsewhere in the island is doubtless due to the belief that the gold deposits in other sections have become so nearly exhausted as to preclude their extraction in quantities profitable even for the peon class.

BASE METALS.

The foregoing description of the situation relative to precious metals applies almost in its entirety to the baser metals. The following mining claims have been filed and are registered in the office of the Commissioner of the Interior of Porto Rico, but no single one of the mines appearing in the list is actually being operated.

Registered mining claims of base metals.

NAME OF OWNER.	Name of mine.	LOCATION OF MINE.			AREA OF MINE—		Class of mineral said to exist.
		Department.	Municipal district.	Ward.	In hectares.	In acres.	
Arturo H. Noble	Corcega	Ponce	Adjuntas	Guilarte	12	30	Copper.
John W. Conner	Freddie	Mayaguez	San German	Hoconuco Bajo	18	44	Do.
Pedro Santisteban	Soledad	Bayamon	Corozal	Padilla	6	15	Do.
Do	Elena and Eugenia	Mayaguez	Lajas	Lajas Arriba	15	37	Copper and other.
Do	Capron	do	do	do	15	37	Do.
Angel Mattey	Mercedes	Arecibo	Utuado	Jayuya	12	30	Copper and iron.
Henry D. Sayre	Anaconda No. 2	Mayaguez	San German	Cain Alto	40	99	Copper and other.
Miguel Porrata	Maria Josefina	Ponce	Ponce	Tibes	25	62	Do.
Alejandro Fernandez	Perseverancia	Humacao	Naguabo	Rio Blanco	12	30	Copper carbonate.
Manuel Ugalde	Esperanza	do	do	do	12	30	Do.
Argueso & Miner	Santa Amalia	do	do	do	100	247	Copper sulphate.
Pedro Santisteban	Santa Agueda	Mayaguez	Lajas	Lajas Arriba	15	37	Copper sulphate and carbonate.
Miguel Planellas	Estrella	Guayama	Guayama	Carmen	12	30	Lead.
Arturo Aponte	Rosita	do	do	do	12	30	Galena.
Pedro Santisteban	Esperanza	do	Juncos	La Ceiba	96	237	Iron.
Do	Eloisa	Humacao	Piedras	Colores	25	62	Do.
Do	Carranzana	Guayama	Juncos	do	20	49	Do.
Do	Palonia	Humacao	Piedras	Boqueron	40	99	Do.
Do	San Miguel	do	do	Colores	21	52	Do.
Do	San Anton	do	Humacao	Collores	12	30	Do.
Do	Begoña	do	Piedras	Colores	21	52	Do.
Do	Luisa	do	do	do	13	32	Do.
Do	Buen Suceso	Guayama	Gurabo	Mamey	71	175	Do.
Do	Providencia	Humacao	Patillas	Mariana	50	124	Do.
Jose Santisteban	San Pedro	do	Piedras	Boqueron	39	96	Do.
Do	San Ramon	do	do	do	47	116	Do.
Do	San Jose	do	do	do	28	69	Do.
Do	Asuncion	Guayama	Gurabo	Jagual	30	74	Do.
Do	Valentina	Humacao	Piedras	Colores	15	37	Do.
Do	Santo Tomas	do	do	do	12	30	Do.
Tomas R. Nido	Fortuna	Guayama	Arroyo	Ancones	24	59	Do.
Carlos McCormick	Idalia	do	do	Laurel	77	190	Do.
Guillermo McCormick	El Bronce	do	do	do	31	77	Do.
Cayetano Rangel	La Victoria	Ponce	Ponce	Portugues	6	15	Do.
Pedro Santisteban	Sabina	Humacao	Humacao	Collores	36	89	Iron and other.
M. Porrata Doria	Celina	do	Fajardo	Chupacallos	24	59	Do.
Argueso & Miner	Maria	do	Humacao	Mariana	8	20	Do.
J. Cobian Valdes	Casualidad	Guayama	Arroyo	Ancones	18	44	Oxide of iron.
Carlos McCormick	Seguridad	do	do	Laurel	54	133	Do.
Tomas R. Nido	Mercedita	do	do	do	93	230	Do.
Carlos McCormick	Palmira	do	do	do	62	153	Do.
Do	Margarita	do	do	do	53	131	Do.
Raimundo Uriarte	Aurora	Ponce	Ponce	Tibes	24	59	Do.
Pedro Gandia	Natividad	Humacao	Patillas	Real	54	133	Do.
Pedro Santisteban	Caridad	Guayama	Gurabo	Mamey	21	52	Do.
Do	La Fe	do	Juncos	Ceiba Norte	14	35	Sesquioxide of iron.
Ramon Latimer	Pilar	Bayamon	Corozal	Palmarejo	12	30	Pirolusita.

A letter of inquiry was sent to each of the owners of the above claims. The replies received may be classified as follows:

Not operated.—Pilar, Natividad, Aurora, Fortuna, Merceditas, Soledad, Eugenia, Capron, Santa Agueda, Eloisa, Esperanza, Carranzana, San Miguel, San Anton, Begoña, Luisa, Buen Suceso, Providencia, Sabina, Caridad, La Fe, San Ramon, San Jose, Asuncion, Valentina, San Pedro, Palonia, Santo Tomas, Mercedes.

Operations suspended.—Estrella, Rosita.

Operations confined to exploration and assay.—Maria Josefina, Celina.

Not reported.—Corcega, Freddie, Anaconda No. 2, Perseverancia, Santa Amalia, Idalia, El Bronce, La Victoria, Maria, Casualidad, Seguridad, Palmira, Margarita.

It is understood that some of the iron ore deposits are of an exceptionally rich character, fully equal in percentage of mineral to the famous Daiquiri mines near Santiago de Cuba. These deposits are situated inland some five or six miles from the eastern seacoast town of Naguabo, and can not be operated with profit until means of transportation is furnished to tide water.

SALT.

The production of salt in Porto Rico is confined exclusively to the southern coast. The process of solar evaporation is the only one employed, and that in its most primitive form. The consumption of this article, estimated from the best data obtainable, is about 300,000 quintals (15,000 tons) per year. All salt required for home consumption, as well as a large amount in excess for export purposes, could readily be produced in the island, but owing to insufficient capital (as alleged by persons engaged in the industry), want of skill in operating, or inclemency of the elements, and notwithstanding the fact that a protective duty of 12 cents per hundredweight has been imposed on foreign salt introduced into Porto Rico, thousands of tons of this commodity are annually imported from Curaçao. The Curaçao salt meets with ready sale here at prices ranging from 20 to 50 cents per quintal, whereas it is claimed that with proper management salt can be produced in Porto Rico at a maximum cost of 10 cents per quintal.

The production of salt in 1902 was almost nil. A canvass gave the following results:

Production of salt: 1902.

NAME OF OPERATOR.	Address of operator.	LOCATION OF WORKS.		Salt produced.	Package.	Value of package.	Net value of salt.	Process employed.
		Department.	Municipal district.					
Juan Padilla	Cabo Rojo	Ponce	Yauco	[1]5,000	Sack	$0.16	$1,250	Solar.
Anecto Caballero	Salinas	Guayama	Salinas	[1]2,000	do		800	Do.
Juan Miguel Toro	Cabo Rojo	Mayaguez	Cabo Rojo	[2]650	do		540	Do.
U. Lopez & Co	San German	do	Lajas		do	.06		Do.

[1] Hundredweight.

[2] Bushels.

In view of the abnormally small production of salt in Porto Rico in 1902, shown in the above statement, it is of interest to reproduce here the reasons advanced therefor by some of the operators:

> The reason of the production of the extremely small quantity of 650 bushels is the heavy rains which fell during the year 1902. In other years six, eight, or ten times the amount was produced.
>
> The insignificant duties paid by foreign salts give rise to the anomalous condition in Porto Rico of importations from Curaçao and other places of a larger amount of salt than is manufactured in the island.
>
> During the year 1902 no salt was produced from the deposit (Fortuna), the hurricane of 1899 having completely destroyed its utility to its former owners, and the whole of said year (1902) being employed by its present lessees in getting it into shape again.
>
> Said deposits (Carmen and Monserrate) have in former years produced 25,000 to 30,000 quintals. The small production in 1902 was owing to the early rains along this coast.
>
> The salt industry of Porto Rico does not produce the fifth of what it should, owing to the lack of capital on the part of the operators. With an initial expenditure of $5,000 the deposit I own should produce 100,000 quintals of salt.

CLAY PRODUCTS.

No attempt has heretofore been made in Porto Rico to canvass this industry, consequently there were no initial data available to aid in the present study. It was known, in a general way, that bricks were made in the island, also that no modern machinery was utilized in their manufacture.

That the industry was not extensive or important was quite evident from the absence of brick edifices and the almost universal use of lumber in the construction of dwelling houses, except in the cities of San Juan, Ponce, and Mayaguez. This first inquiry, therefore, could not be other than crude and incomplete, by reason of the following facts: (1) No previous statistics existed showing establishments engaged in the industry; (2) brickmaking was not engaged in continuously by any one establishment, ovens being baked, from time to time, as the necessity demanded; (3) lack of precise information on the part of the operators themselves as to number of bricks made, their actual cost, average selling price, etc. For the foregoing reasons it is apparent that many persons who engage in the manufacture of brick as occasion therefor arises could not be reached at all. In the brief period at the disposal of the writer it was not possible to ascertain the location of more than 35 operators. Of these, 30 were successfully interrogated, with the results shown in the following table:

Clay products: 1902.

NAME OF OWNER.	LOCATION OF OFFICE AND FACTORY.		COMMON BRICK.			KILNS.	
	Department.	Municipal district.	Number.	Value.	Process used in making.	Kind used	Number used.
Luis A. Bonnet	Vieques	Vieques	150,000	$1,500	Hand labor	Brick oven	1
Gavino Garcés	Mayaguez	San German	60,000	300	do	do	2
Mariano Gonzalez	Bayamon	Carolina	120,000	250	do	do	1
Francisco Parra	Ponce	Santa Isabel	150,000	750	do	do	1
Federico Guzman	Mayaguez	San German	50,000	300	do	do	1
Santos Franceschi	Ponce	Coamo	20,700	144	do	do	1
Jesus Diaz	do	Yauco	100,000	500	do	do	2
Hacienda Florida	do	do	150,000	750	do	do	3
Isidro Sanjurjo	Mayaguez	Mayaguez	240,000	1,680	do	do	2
Mariano Renovales	Ponce	Juana Diaz	100,000	720	do	do	2
Vilella Hermanos	Aguadilla	Lares	50,000	400	do	do	1
José Irizarri	Ponce	Ponce	200,000	1,200	do	do	1
N. Arabia	do	do	800,000	5,200	do	do	2
Teresa Bardeguez	Humacao	Yabucoa	36,000	324	do	do	1
Succn. C. Velasquez	Ponce	Juana Diaz	120,000	720	do	do	1
Severiano Ramirez	Mayaguez	Cabo Rojo	70,000	350	do	do	2
Gumersindo Lluch	do	do	17,000	135	do	do	1
Manuel G. Muñoz	Guayama	Cayey	80,000	640	do	do	1
M. Munitiz	do	do	80,000	480	do	do	1
Soc. Agricola "Tuna"	do	Guayama	250,000	2,000	do	do	2
Alfredo Cristy	Mayaguez	Mayaguez	180,000	1,260	do	do	1
Balbino Rodriguez	Aguadilla	Aguada	20,000	140	do	do	1
Fco. Antongiorgi	Ponce	Yauco	150,000	750	do	do	3
Mariana Sierra	Aguadilla	Aguadilla	66,650	550	do	do	1
Viuda de Battle	Mayaguez	Mayaguez	46,700	340	do	do	1
F. A. Vendrell	Ponce	Santa Isabel	50,000	200	do	do	1
Federico Gatell	Mayaguez	Mayaguez	100,000	700	do	do	2
J. Caloca	Bayamon	Rio Piedras	150,000	1,200	do	do	1
Juan Perez	do	do	137,000	1,080	do	do	1
Ca. Azucarera del Este	Humacao	Yabucoa	115,565	1,155	do	do	1
Total			3,887,265	24,890			45

PORTO RICO—OX-POWER WHEEL FOR MIXING CLAY.

PORTO RICO—MOULDING BRICKS BY HAND.

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The foregoing table shows that in 45 kilns 3,837,255 common bricks, valued at $25,899, were produced in 1902, or an average price of $6.75 per thousand. It is not believed, however, that this actually represents the total number of bricks manufactured in one year in Porto Rico; probably three times the above number would more nearly approach a correct estimate. The process employed is absolutely and literally the hand process, and consists in mixing the clay with water in a wooden trough until the requisite consistency is obtained. The mass is then molded into bricks by hand, the operator employing a wooden mold for that purpose. The crude bricks are afterwards placed in a brick oven and baked, when they are ready for market. Bricks made in this manner are not nearly so durable as those manufactured in the United States by means of approved modern machinery. Clay roofing tiles were extensively manufactured in Porto Rico at one time, but since the introduction of cheap iron roofing have entirely disappeared from use.

LIMESTONE.

With the exception of the fringe of flat lands lying between the coast line and the mountainous formations in the interior, the island of Porto Rico is practically one vast limestone deposit. Owing to its abundance and accessibility, and to the fact that its conversion into the proper form for use in building and kindred purposes requires no large outlay of capital, the industries having to do with lime rock, while quite numerous, are too scattered and unimportant to admit of the compilation of statistics on any elaborate scale. It is by reason of the foregoing considerations, also, that limestone and its products command no stable price in Porto Rico. Owing to the propinquity of certain quarries to points at which the material is needed, owners of such quarries can at times find a market for limited quantities of the stone at prices ranging from 3 to 10 cents per cubic meter. In such cases, however, the actual work of the extraction of the stone and its subsequent delivery to the place where required is generally attended to by the purchaser of the stone rather than by the owner of the quarry, and on account of the insignificant value of the material no attempt is made to keep an accurate record of the quantity used. By far the most important item of expense in connection with the use of the stone is that of transportation. The following table of quarries adjacent to the principal public highways already constructed or in course of construction in Porto Rico, many of which are themselves constructed of and upon limestone formations, will serve to illustrate the bountifulness of the supply of lime rock in the island. A list is given of the quarries that have been opened up and from which limestone has been actually extracted. These quarries are grouped according to the highway near which they are located, and their exact location is shown in the first column, which gives the number of kilometers and meters with the equivalent in miles and yards they are distant from the town first mentioned after name of the road at the head of the respective groupings:

Road from San Juan to Ponce.

LOCATION.		Kind of stone.	Owner.
In kilometers and meters.	In miles and yards.		
7.700	4-1,381	White limestone	P. Ubarry.
20.300	12-1,080	Blue limestone	Public works.
25.200	15-1,159	Calcareous	Do.
25.200	15-1,159	....do	P. Larrosa.
54.900	34-199	....do	L. Rodriguez.
55.800	34-1,184	....do	N. Nunez.
61.100	37-1,700	....do	J. Fernandez.
63.000	39-268	....do	F. Fernandez.
67.000	41-1,112	Limestone	Heracio Mendoza.
73.200	45-852	....do	Public works.
78.200	48-1,040	....do	Gavino Rodriguez.
84.000	52-343	....do	Public works.
85.100	52-1,546	....do	—, Taboada.
87.700	54-870	....do	Public works.
90.900	56-849	....do	Dona Paz.
94.200	58-938	....do	Domingo Emanuelli.
99.500	61-1,454	....do	Teodoro Santiago.
100.300	62-569	....do	Julio M. Larrauri.
104.100	64-1,205	....do	Jorge Velez.
105.300	65-757	....do	Pedro Quevedo.
106.600	66-419	....do	C. Caratini.
107.500	66-1,403	....do	Do.
108.200	67-409	....do	Remigio Mateo.
111.900	69-935	Blue limestone	José Esbri.
111.100	69-60	....do	Julian Plaza.
114.300	71-40	....do	Sucesores Gallart.
120.100	74-1,102	White and yellow limestone.	Manuel Cristian.
125.400	77-1,619	....do	Sucesores Serralles.
126.600	78-1,171	....do	Manuel Leon Parra.
126.100	78-624	Blue limestone	Joaquin Arce.
128.100	79-1,052	....do	José S. Valdes.
129.200	80-495	White and yellow limestone.	José Usera.

Road from Cataño to Vega Alta.

6.900	4-506	White limestone	P. Lavandero.
7.900	4-1,600	....do	A. Santos.
11.600	7-366	....do	A. Acevedo.
11.900	7-694	....do	S. Olivo.
13.300	8-465	....do	
14.900	9-455	....do	I. Sanchez.
15.100	9-674	....do	J. Perez.
15.100	9-674	....do	N. Roman.
15.100	9-674	....do	L. La Cruz.
16.500	10-445	....do	S. Martinez.
17.200	10-1,210	....do	I. Sanchez.
20.200	12-971	....do	A. Echeveste.
23.300	14-841	....do	Mr. Miner.
23.700	14-1,279	....do	Mr. Lothrop.
24.200	15-65	....do	Mr. Stevens.

Road from Caguas to Humacao.

6.700	4-287	Blue limestone	M. Portela.
7.200	4-834	....do	F. Echevarria.
9.700	6-48	....do	T. Hernandez.
11.500	7-257	White limestone	R. Jimenez.
13.900	8-856	....do	M. Mendez.
14.500	9-17	....do	Sucesores Farrin.
14.700	9-236	....do	Sucesores Rodriguez.
16.000	9-1,658	....do	C. Serrano.
17.450	10-1,484	....do	Sucesores Rodriguez.
19.500	12-205	....do	Julio Gay.
22.800	14-294	Blue limestone	S. Rivera.
25.400	15-1,378	....do	F. Lopez.
25.500	15-1,487	....do	Do.
28.100	17-810	....do	Luis Celis.
28.100	17-810	....do	F. Arroyo.
32.400	20-233	Dark limestone	S. Romfort.
34.500	21-770	....do	D. Carmona.

Road from Rio Piedras to Fajardo.

LOCATION.		Kind of stone.	Owner.
In kilometers and meters.	In miles and yards.		
2.200	1-646	Blue limestone	J. Gonzalez.
2.700	1-1,193	White limestone	Manuel Falu.
3.800	2-636	do	E. Gómez.
5.000	3-188	do	E. Van Rhyn.
5.500	3-735	do	José Ubarry.
8.400	5-386	Blue limestone	M. Pérez.
11.100	6-1,579	do	S. de Ezquiaga.
15.100	9-674	do	Francisco Jimenez.
16.200	10-117	do	Basilio Pineiro.
16.600	10-554	do	R. H. Delgado.
18.300	11-653	Yellow limestone	Factoria Central.

Road from Reyes Catolicos Bridge to Corozal.

2.300	1-755	White limestone	I. Sanchez.

Road from Manati to Ciales.

1.400	0-1,531	White limestone	F. Calaf.
8.900	5-933	do	V. Cortes.
10.110	6-496	do	F. Caso.
11.500	7-257	do	Fernández & Co.

Morovis Branch.

3.700	2-526	White limestone	F. Fuxench.
5.006	3-195	do	E. Cacho.
8.000	4-1,709	do	J. Cordero.

Comerio Road.

1.100	0-1,203	White limestone	J. R. Carmona.
2.800	1-1,302	do	M. Ponton.

Road from Cayey to Arroyo.

LOCATION.		Kind of stone.	Owner.
In kilometers and meters.	In miles and yards.		
1.420	0-1,553	Limestone	Joaquin Fernández.
4.000	2-854	White limestone	Public works.
5.000	3-188	do	Do.
8.000	4-1,709	do	Do.
12.000	7-803	do	Do.
14.800	9-345	Limestone	C. Cruet.
23.500	14-1,060	do	F. Ortiz.
28.800	17-1,576	do	Guayama municipality.

Road from Ponce to Adjuntas.

1.500	0-1,640	Limestone	José Irizarry.
2.800	1-1,302	do	Julio N. Chardon.
3.200	1-1,740	do	Do.
3.200	1-1,740	do	Tomás Armstrong.
3.300	2-89	do	Sucesores Chardon.

The statements in regard to limestone preceding the above table apply with equal force to lime in its commercial forms. Practically every farmer in the interior of the island can, and does, produce lime in greater or less quantities, according to his needs, of which no account is kept. A canvass of such persons as could be ascertained to be engaged in the sale of lime in any of its forms gave the results appearing in the following table:

Production of limestone: 1902.

NAME OF OWNER.	LOCATION OF QUARRY.		LIMESTONE QUARRIED.						CRUSHED STONE FOR ROADMAKING.			Total value.	Condition of trade in 1901 compared with 1902.
			For building purposes.			Stone burned into lime.			Quantity—		Value.		
			Quantity—		Value.	Quantity—		Value.					
	Department.	Municipal district.	In cubic meters.	In cubic yards.		In cubic meters.	In cubic yards.		In cubic meters.	In cubic yards.			
Tomás Armstrong	Ponce	Ponce							80	106	$60	$60	About the same.
Victor Martino	do	do	30	39	$90	115	151	$347				437	In 1901 better than in 1902.
Francisco Fiol	do	do							950	1,243	95	95	
Narciso Manescau	do	do	33	43	16							16	In 1901, flourishing; in 1902, dull.
José B. Ortiz	do	do	50	65	15							15	
Trujillo & M. Mercado	do	do				400	523	150				150	In 1901 better than in 1902.
Esteban de Leon	do	do				50	65	25				25	
José F. Valls	do	do				200	262	600				600	Much better in 1901.
Clavell Hermanos	do	do				70	92	210				210	1901 the same as 1902.
Ramón Ortiz Quintana	do	do				20	26	60				60	Much better in 1902.
Jaime Bas Garcia	do	do	50	65	25							25	
Esteban Ortiz	do	do							950	1,243	2,177	2,177	
Carlos Gilot	do	do							915	1,197	2,096	2,096	
Monserrate Ramos	Mayaguez	Cabo Rojo							90	118	243	243	Not operated.
José Villa	do	do							60	78	16	16	Not operated in 1901.
José Ortiz	do	do							40	52	4	4	
Sebastián Bausá	Bayamon	Bayamon							500	654	25	25	1901 the same as 1902.
Juan B. Cesareo	do	do				65	85	26				26	Better in 1902.
Vilella U. Hermanos	Aguadilla	Lares				100	131	50				50	Quarried only 65 cubic yards in 1901.
Emilio Torres	do	do	50	65	25				80	106	40	65	Not operated in 1901.
E. B. Pérez	Mayaguez	Las Marias				77	101	180				180	Do.
F. Philippi	do	do				25	33	100				100	1901 the same as 1902.
Marcos Ortiz	Ponce	Juana Diaz				60	78	240				240	Do.
Cristino Siuró	do	do	[1] 15	20	45	60	78	180				225	
C. Dejardins	Mayaguez	Maricao				20	26	10				10	1901 the same as 1902.
Nicanor Santana	do	do				50	65						
José B. Dumont	Guayama	Cayey				15	20	75				75	1901 the same as 1902.
Vicente Vazquez Martinez.	do	do				14	18						Do.

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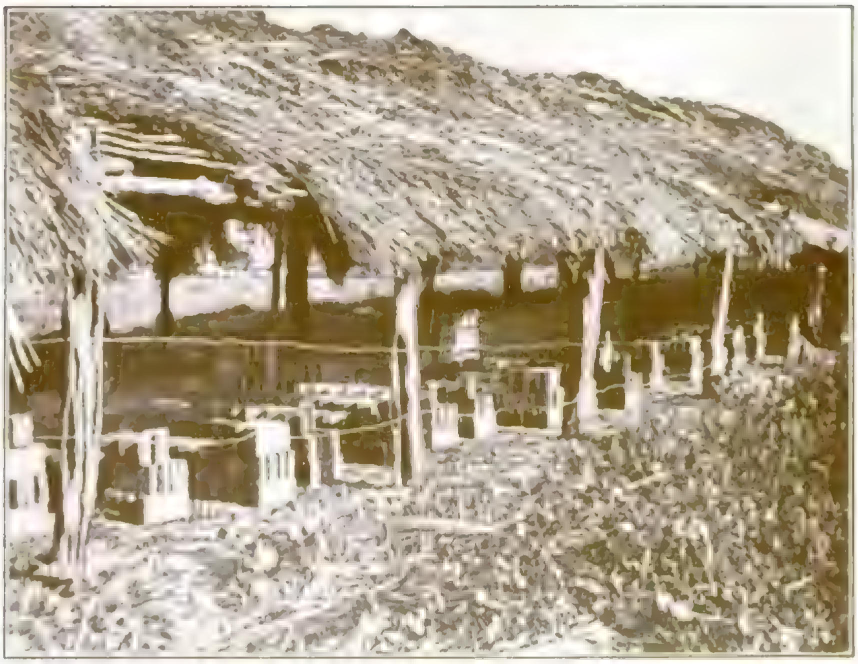
[1] For flagging.



PORTO RICO—DRYING BRICKS PREVIOUS TO FIRING.

PORTO RICO—FIRING A BRICK-LOADED OVEN.

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Production of limestone: 1902—Continued.

NAME OF OWNER.	LOCATION OF QUARRY.		LIMESTONE QUARRIED.						CRUSHED STONE FOR ROADMAKING.			Total value.	Condition of trade in 1901 compared with 1902.
			For building purposes.			Stone burned into lime.			Quantity—				
	Department	Municipal district.	Quantity— In cubic meters.	Quantity— In cubic yards.	Value.	Quantity— In cubic meters.	Quantity— In cubic yards.	Value.	In cubic meters.	In cubic yards.	Value.		
Eugenio Gómez	Bayamon	Rio Piedras							100	131			
Juan Mollfulleda	do	Carolina				24	31	$58				$58	Better in 1901.
Eladio Marquez	do	do							250	327	$3	3	
Sobrinos de Ezquiaga	do	do				25	33	100				100	Not operated.
Juan Moreno Aviles	Mayaguez	Añasco				60	78						1901 the same as 1902
J. Sabater Rivera	Guayama	Salinas				350	458	300				300	Do.
Rafael Diaz	Ponce	Yauco				60	78	51				30	
Segundo Castilló	Mayaguez	Mayaguez							239	313	358	358	1901 better than 1902
Odon Semonte	Guayama	Caguas				80	105	20				20	1902 the same as 1902.
Jorge Bird Arias	Humacao	Fajardo	198	259	$229	25	33	400				629	Demand very small; trade in 1902 about the same as 1901
José R. Fernández	Guayama	Caguas				80	105	16				16	1901 the same as 1902.
Pablo Ubarri	Bayamon	San Juan	100	131	150				1,250	1,570	1,500	1,650	
Francisco Jimenez	do	Carolina				72	94	90				90	
Santiago Colon	Ponce	Ponce				200	262	150				150	Better in 1902.
Bonifacio Ormendo	Bayamon	Bayamon				150	196	45				45	1901 the same as 1902.
Fernando Salgado	do	do				140	183	42				42	Do.
Ramón Millan	Arecibo	Camuy				400	392	70				70	Do.
Julio N. Chardon	Ponce	Ponce				10	13	25	100	131	10	35	Do.
Ulises Garcia Salgado	Bayamon	Rio Piedras	20	26	40	120	157	900				940	Do.
Eduardo Valdivieso	Ponce	Ponce				100	131	30				30	Dull in 1902
Segundo T. Fradera	Mayaguez	Lajas				3	4						
F. A. Vendrell	Ponce	Santa Isabel				4	5	1				1	1901 better than 1902.
Juan Valls	do	do				40	52	80				80	Not operated in 1901
Baldomero Vera	Arecibo	Utuado				20	26	40				40	1901 the same as 1902
Federico Juarbe	do	Arecibo							61	80	103	103	Not operated in 1901.
José Ubarri	Bayamon	Rio Piedras				20	26	1	100	131	7	8	1901 the same as 1902.
José Castelló	Mayaguez	Cabo Rojo				20	26	20				20	
Guanica Centrale	Ponce	Yauco	5,500	7,194	5,500	500	654	500	[1]4,500	5,886	4,500	10,500	
Total			6,043	7,903	[2]6,025	3,744	4,896	5,411	10,215	13,364	[3]11,237	22,586	

[1] For railroad ballast.

[2] Includes 15 cubic meters (20 cubic yards), valued at $45, used for flagging.

[3] Includes 4,500 cubic meters (5,886 cubic yards), valued at $4,500, used for railroad ballast.

Whenever the demand is such as to make the production of an oven of lime sufficiently lucrative the farmer will prepare one and take it to the nearest market. The production of lime in Porto Rico, therefore, is important rather by reason of the large number of persons engaged therein on a small scale than on account of commercial importance. A certain amount of lime is used by the sugar factories to clarify sirup. In response to interrogatories as to quantity and cost of the lime thus used at the more important factories in the course of a year, the owners stated that where the lime was not to be had on their own premises it was usually obtained from some neighboring deposit gratis.

The limestone formations may be divided into two classes, white and yellow. There are also deposits, few in number, of a blue limestone, somewhat resembling granite formation, and of much harder composition than either the white or yellow varieties mentioned above.

PHOSPHATE ROCK.

There are four phosphate rock mining claims registered in the office of the Commissioner of the Interior of Porto Rico, none of which is being operated at present, viz:

Registered mining claims of phosphate rock.

NAME OF OWNER.	Name of mine.	LOCATION OF MINE.			AREA OF MINE—		Class of mineral
		Department.	Municipal district.	Ward	In hectares.	In acres.	
Alfredo Collado	Fortuna	Mayaguez	Cabo Rojo	Monte Grande	6	15	Phosphate rock.
Miguel Arzuaga	La Confianza	Arecibo	Manati	Las Boquillas	6	15	Do.
Joaquin de Alarcon	Trabajo	Aguadilla	Isabela	Arenales Bajos	12	30	Do.
J. Sanchez Valdes	Joachin and San Jose.	Ponce	Ponce		12	30	Do.

There are other deposits of phosphate rock not registered, as shown in the following table, one of which it is claimed produced 50 tons during the year 1902:

Unregistered mining claims of phosphate rock.

NAME OF OWNER.	Address of owner.	LOCATION OF MINE.			TOTAL AMOUNT IN TONS.		Value of sales.
		Department.	Municipal district.	Ward.	Produced	Sold	
Domingo Emanuelli	Coamo	Ponce	Coamo	Palmarejo	50	35	$105
M. Porrata Doria	Ponce	do	Ponce	Caja de Muertos			
Fausta Aponte	Coamo	do	Coamo	San Ildefonso			
Miguel Arzuaga	Barceloneta	Arecibo	Manati	Las Boquillas			
José Sanchez Valdes	Ponce	Ponce	Ponce	Machuelo			
Felipe Alfaro	Isabela	Aguadilla	Isabela	Arenales Bajos			

The insular government is the owner of the largest known deposit of phosphate rock, which is situated in the island of Caja de Muertos. This deposit was formerly operated on an extensive scale and the product shipped to Germany. It is idle at the present time, however, pending action by the executive council of Porto Rico upon a franchise to work the deposit, for which application has been made. In statistics previously compiled on this subject, deposits of bat guano have been confused with phosphate rock in consequence of such guano being found upon rocks or in caves of a phosphatic character.

GRANITE.

It is not believed that any real granite is to be found in Porto Rico. Two residents of the central section of the island claiming to have discovered granite on their premises gave the information that only 18 cubic meters (24 cubic yards) had been sold in the rough for curbing purposes and 81 cubic meters (106 cubic yards) crushed for roadmaking purposes. It is probable, however, that the stone in question is of dioritic formation and not granite, as they allege.

MINERAL SPRINGS.

There are four widely known mineral springs in Porto Rico, the waters of which contain medicinal properties of no mean value. They are:

Mineral springs in Porto Rico.

NAME OF OWNER.	Residence of owner.	Date of report.	Name of spring.	LOCATION OF SPRING.			Remarks.
				Department.	Municipal district.	Ward.	
Sucesión Usera	Coamo	June 4, 1903	Coamo, Maria	Ponce	Coamo	San Ildefonso	Used only as baths.
Virella U. Hermanos	Arroyo	do	Carmen, Dolores	Guayama	Arroyo	Algarrobo	Do.
Guillermo Orrach	Caguas	do	Florencio	do	Caguas	Bairoa	Do.
Sucesión Ortiz	Ponce	May 22, 1903	Quintana	Ponce	Ponce	Portugues	Do.

The first-named spring is famous locally as a health resort, there being a well-appointed hotel furnishing accommodations for 110 guests. The waters are supplied to visitors in the form of hot and cold baths and for drinking purposes, but have never been bottled, nor has any attempt been made to put them on the market. The springs run from a soft red sandstone, at an altitude of 196.85 feet above sea level, with a temperature, at point of exit, of 43° C. An analysis by Quintanilla in 1891 gave:

Gases in solution, per liter of water at 0° C. temperature and 760 millimeters pressure:

	Cubic centimeters.	Cubic inches.
Nitrogen	13.740	0.84
Oxygen	1.761	0.11
Hydrogen sulphide	1.967	0.12

Fixed elements, per liter:

	Grams.	Grains.
Free carbonic acid	0.01296	0.20000
Sulphate of lime	0.79903	12.33063
Sulphate of soda	0.52531	8.10658
Chloride of potash	0.00031	0.00478
Chloride of sodium	0.22054	3.40337
Silicate of soda	0.08127	1.25416
Carbonate of soda	0.03503	0.54058
Ferrous carbonate	0.01114	0.17191

Traces of tannic, nitric, and boric acids and bromine and lithia.

The Florencio springs are not operated for the benefit of the public. There is a private bath house used by the family of the proprietor and by other persons by special permission. The waters have never been bottled nor put on the market. The proprietor states that local physicians prescribe the waters for skin diseases and stomach troubles, but that a scientific analysis has never been made.

PORTO RICO—LIMESTONE QUARRIES.

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The Quintana springs, near the town of Ponce, are also quite extensively known locally as possessing excellent medicinal virtues. The waters are administered in the form of baths, but within recent months, owing to the bad state of the road leading to the baths and the abandoned condition of the establishment itself, the springs have ceased to be a public resort. An analysis made in San Juan in 1894 classifies the water as colorless, odorless, transparent, salty, and somewhat bitter in taste; no matter in suspension; density, 1.0057.

	Cubic centimeters.	Cubic inches.
Gases in solution:		
Ozone	0.0191	0.0012
Oxygen	0.0100	0.0006
Carbonic acid	0.0025	0.0002
Fixed elements, per liter:	Grams.	Grains.
Chloride of sodium	0.519	8.009
Chloride of magnesia	0.015	0.231
Sulphate of soda	0.123	1.898
Sulphate of potash	0.021	0.324
Sulphate of lime	0.081	1.250
Carbonate of lime	0.122	1.883
Ferrous carbonate	0.012	0.185
Silica	0.032	0.494
Organic matter	0.050	0.772

Traces of manganese and bromine.

The Arroyo springs are not operated by the proprietors, who state that no trustworthy analysis of the waters has as yet been made.

Accompanying this report is a map showing approximately the location of mining claims, salt deposits, and mineral springs in Porto Rico. Owing to the fact that no scientific triangulation or survey of the island has ever been made, it has been impossible to indicate on the map with exactness the geographical position of these claims. It is believed, however, that the general purpose of showing the approximate location of the mining deposits of Porto Rico is sufficiently well served. The reason given above with respect to the want of exactness in the location of mining claims applies to the boundaries separating municipalities as well.

Every effort was made to obtain data showing the number of persons employed during the year in the exploitation of the mineral resources of the island. For obvious reasons such an effort could not meet with any great degree of success. As has been stated, in no case were mines or quarries operated during the year as a continuous industrial enterprise. Even in respect to such work as brickmaking, lime burning, or quarrying, operations were of an intermittent character. As regards quarrying, the rock was usually taken out by the contractors engaged upon road construction or repair in connection with their other work. No amount of research, therefore, would have permitted a definite statement either of the total output or of the number of persons employed. The best that can be done is to make a rough estimate, based upon the general information secured, in obtaining the data for the report of the probable average number of persons that may be said to have gained a livelihood in some capacity in connection with the exploitation of the mineral resources of the island.

In respect to the extraction of precious metals, a fair estimate would put the average number of men constantly employed during the year in exploitation work for gold mines and the laying out of claims and similar work at twenty-five. Thirty additional men were probably employed in placer mining, chiefly in the Corozal district. Exploitation and field work in connection with copper mines probably did not engage more than ten men. About one hundred and fifty men may be said to have been constantly employed in the operation of salt mines. Brickmaking probably gave employment to an equivalent of two hundred men working all the year. Estimating from the amount of limestone extracted for the purpose of roadmaking and repairs and for burning, an exceedingly rough approximation would place the amount of labor expended in limestone quarrying operations at five hundred men. As only 50 tons of phosphate rock were mined during 1902, probably not more than two or three men had constant employment during the year.

That Porto Rico possesses mineral resources that will be of great value to the island in future years there can be no doubt. In their utilization the stage as yet has only been reached where efforts are being made to determine more exactly their character and extent. Authorization for water rights and concessions of various characters are being constantly sought of the insular government, and it is certain that when another investigation along the lines of the present one is made the phase of industrial exploitation in respect to a number of minerals will have been definitely entered upon.

APPENDICES

APPENDIX A.—SCHEDULES

APPENDIX B.—INSTRUCTIONS TO SPECIAL AGENTS

APPENDIX C.—INSTRUCTIONS FOR EDITING AND REVISING THE SCHEDULES

APPENDIX A.

SCHEDULES.

Schedule No. 6.—Intended for all mineral industries for which no special schedule is provided. (*Number printed, 100,000.*)

United States Census Office.
Special Schedule No. 6.

DIVISION OF MANUFACTURES
S. N. D. North, Chief Statistician

MINES AND QUARRIES.

Name of mine or quarry ....
Character of mineral ....
Name of company, firm, or individual owner ....
Location of mine or quarry: State ....; County ....
Nearest city or town ....; Post office ....
General office at ....
....

United States Census Office
Washington, D. C., January [illegible], 1903.

By section 7 of the act of Congress for the establishment of a permanent Census Office approved March 6, 1902 the Director of the Census is required to prepare a report on mines, mining, quarries and minerals and the production and value thereof, including gold in divisions of placer and vein, and silver mines, of the United States and the following schedule has been formulated for that purpose.

For the convenience of producers, the United States Geological Survey will distribute and receive these schedules in connection with the returns for its annual report.

The information returned on this schedule should cover the business year of the establishment most nearly conforming to the year ending December 31, 1902.

All answers will be held absolutely confidential. No publication will be made in the census reports disclosing the names or operations of individual establishments in any particular. Special agents and enumerators of the census are liable to a penalty of $500 if they disclose any information obtained in their official capacity.

William R. Merriam,
Director of the Census.

Extract from act of Congress, March 3, 1899:

Section 22. * * * "And every president, treasurer, secretary, director, agent, or other officer of every corporation, and every establishment of productive industry, whether conducted as a corporate body, limited liability company, or by private individuals, from which answers to any of the schedules, inquiries, or statistical interrogatories provided for by this act are herein required, who shall, if thereto requested by the Director, supervisor, enumerator, or special agent, willfully neglect or refuse to give true and complete answers to any inquiries authorized by this act, or shall willfully give false information, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not exceeding ten thousand dollars, to which may be added imprisonment for a period not exceeding one year."

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief.

....
(Signature and official designation of the person furnishing the information.)

....
(Signature of special agent.)

1. Character of present organization, whether individual, firm, limited partnership, cooperative association, or incorporated company: ....

2. Capital stock, bonds, dividends, and assessments (if an incorporated company).

	BONDS.		PREFERRED STOCK.		COMMON STOCK.	
	Number.	Total par value.	Number of shares.	Total par value.	Number of shares.	Total par value.
Authorized	......	$	......	$	......	$ ......
Issued to the end of the year	......	......	......	......	......	......

Dividends and interest, if any, paid during the year:

Common stock, rate ....; amount, $ ....
Preferred stock, rate ....; amount, $ ....
Bonds, rate ....; amount, $ ....

Assessments: Total amount levied, if any, since organization of company .... $ ....

3. Persons employed:

CLASSES.	Average number employed during the year.	Total amount paid in wages or salaries during the year.
Above ground:		
General officers	......	$ ......
Superintendents, managers, foremen, surveyors, etc	......	......
Clerks	......	......
Engineers, firemen, machinists, blacksmiths, carpenters, and other mechanics	......	......
Miners or quarrymen and stonecutters	......	......
Boys under 16 years	......	......
All other employees	......	......
Below ground (not for quarries or surface mines):		
Foremen	......	......
Miners	......	......
Miners' helpers	......	......
Boys under 16 years	......	......
All other employees	......	......
Total	......	......

(Account for all persons employed at the mine or quarry. Give the total salaries and wages paid, which should include board or rent furnished as part compensation. The wages reported for miners or quarrymen and stonecutters should be their net wages, and should not include the cost of supplies furnished by the company and charged to them, such as explosives, lamp oil, etc., and blacksmithing charges. Care should be taken that those employed "above ground" and those "below ground" be reported separately. Stockholders of corporations are not to be reported unless they are salaried officials. Amounts paid for contract work, not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but be reported in answer to Inquiry 6. The average number employed during the year is the number that would be required, at continuous employment for the twelve months, to produce the quantity of product reported.)

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.

OCCUPATIONS.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
Engineers																	
Firemen																	
Machinists, blacksmiths, carpenters, and other mechanics																	
Miners or quarrymen and stonecutters																	
Miners' helpers																	
Timbermen and track layers																	
Boys under 16 years																	
All other employees, not including those on salaries																	

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH.

MONTH.	Men 16 years and over.	Boys under 16 years.	MONTH.	Men 16 years and over.	Boys under 16 years.
January			July		
February			August		
March			September		
April			October		
May			November		
June			December		

(Only wage-earners should be reported, including miners working on tonnage and other pieceworkers. Do not include firm members, general officers, superintendents, managers, foremen, clerks, and other salaried employees.)

4. If mining or quarrying is paid for by ton, car, yard, or other unit, give rate paid and character of unit, ...

Average number of employees engaged in this class of mining, ...

Total amount paid for such work, $..........

(The rate paid for mining or quarrying not done by the day should be reported, and the average number of employees engaged in such work and the total amount paid.)

5. Time in operation:

Total number of days in operation during the year, ... Number of hours in operation per day, ... Number of shifts of workmen, ... Number of hours to shift, ...

6. Contract work:

Amount paid, if any, for tunneling, shaft sinking, boring test holes, etc., if not done by employees hired directly by this establishment, $........

Average number of men employed on such work, ...

Number of days employed, ...

7. Supplies and materials:

Total cost of supplies and materials of all kinds used during the year, including freight paid on the same, $........

(The actual cost of all supplies and materials used during the year, including freight paid on the same, must be reported. The cost of the following materials should be reported under this inquiry: Lumber and timber used for repairs, mine supports, track ties, cars, and all other purposes; iron and steel for blacksmithing, nails, frogs, sleepers, etc., for tracks and repairs, parts of machinery and tools used for renewals and repairs; explosives, water for boilers and for other purposes, fuel, illuminating and lubricating oils, machinery supplies, etc.)

8. Miscellaneous expenses:

ITEMS.	Amount.
Royalties and rent of mine and mining plant	$
Amount paid for rent of offices, taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere	
Total	$

(All items of expense incident to the operation of the mine or quarry, not accounted for under Inquiries 3 and 7, must be reported here. Do not include any portion of the freight reported under Inquiry 7 as paid on supplies and materials.)

9. Product:

Total quantity of mineral or stone mined during the year, ...

Total value at mine or quarry, $........

(Under this inquiry should be reported the quantity and value of all mineral or stone mined during the year, f. o. b. at mine or quarry, as reported to the United States Geological Survey.)

10. Power:

a. Power owned—

CLASS.	Number.	Total horsepower.
Engines: Steam		
Gas and gasoline		
Water wheels		
Electric motors		
Other power (specify kind)		

b. Power *supplied to* other establishments, if any—horsepower, ...

c. Power *supplied by* other establishments, if any—kind of power, ..., horsepower, ...; name and address of establishment supplying same, ...

(Under this inquiry should be reported all mechanical power employed, either owned or rented, including the number and horsepower of all engines, motors, water wheels, etc., used for hoisting, derricks, surface machinery, ventilating, pumping, and all other purposes.)

Special Schedule No. 8.—For coal mines. (*Number printed, 35,000.*)

First page same as Schedule No. 6.

Inquiries 1 and 2 same as Schedule No. 6.

3. Persons employed:

CLASSES.	Average number employed during the year.	Total amount paid in wages or salaries during the year.
Above ground:		
General officers		$
Superintendents, managers, foremen, surveyors, etc		
Clerks		
Engineers, firemen, machinists, blacksmiths, carpenters, and other mechanics		
Boys under 16 years		
All other employees		
Below ground:		
Foremen		
Miners		
Miners' helpers		
Boys under 16 years		
All other employees		
Total		

(Account for all persons employed at the mine. Give the total salaries and wages paid, which should include board or rent furnished as part compensation. The wages reported for miners should be their net wages, and should not include the cost of supplies furnished by the company and charged to them, such as explosives, lamp oil, etc., and blacksmithing charges. Care should be taken that those employed "above ground" and those "below ground" be reported separately. Stockholders of corporations are not to be reported unless they are salaried officials. Amounts paid for contract work, not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but be reported in answer to Inquiry 6. The average number employed during the year is the number that would be required, at continuous employment for the twelve months, to produce the quantity of product reported.)

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.

OCCUPATIONS.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
Engineers																	
Firemen																	
Machinists, blacksmiths, carpenters, and other mechanics																	
Miners																	
Miners' helpers																	
Timbermen and track layers																	
Boys under 16 years																	
All other employees, not including those on salaries																	

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH.

MONTH.	Men 16 years and over.	Boys under 16 years.	MONTH.	Men 16 years and over.	Boys under 16 years.
January			July		
February			August		
March			September		
April			October		
May			November		
June			December		

(Only wage-earners should be reported, including miners working on tonnage and other pieceworkers. Do not include firm members, general officers, superintendents, managers, foremen, clerks, and other salaried employees.)

4. If mining is paid for by ton, car, yard, or other unit, give rate paid and character of unit, ...

Average number of employees engaged in this class of mining, ...

Total amount paid for such work, $........

Amount paid as yardage or other allowances to miners, if any, $........

(The rate paid for mining not done by the day should be reported, and the number of employees engaged in such work and the total amount paid. If yardage or other allowances are made to miners in consideration of difficult mining, narrow work, or for other causes, the total amount paid as such during the year should be reported under this inquiry.)

Inquiries 5, 6, 7, and 8, same as Schedule No. 6.

9. Product:

Total quantity of marketable coal mined during the year, ...

Total value at mine, $........

Number of mine cars of coal, run of mine, hoisted during the year, ...

Average capacity of mine cars, in pounds, ...

(Under this inquiry should be reported the quantity and value of all coal mined during the year, f. o. b. at mine, as reported to the United States Geological Survey. The number of cars loaded in the mine with their average capacity in pounds, should also be reported.)

Inquiry 10, same as Schedule No. 6.

11. What mechanical system of haulage is employed, if any—tail rope, endless rope, electric locomotive, compressed air, or other kind? ....

12. Are automatic slate pickers or coal cleaners used in the breaker? ....
(Does not apply to bituminous coal mines.)

13. Number of washeries at this colliery, if any, ... and price per ton charged to washeries for culm, ...
(Does not apply to bituminous coal mines.)

14. Nature of openings to the works—shaft, slope, drift or level, open cutting or stripping, or other method, and depth or length in feet of each, ...

15. System of ventilation in use—fan, furnace, fire basket, exhaust steam, natural, or other kind, ...

16. If coal was mined on royalty during the year, give the rate per ton paid, ...

In addition to Special Schedule No. 8 for coal mines of a commercial character, there was provided for small country coal banks to which Special Schedule No. 8 could not be applied a simpler form of combined letter and schedule.

Schedule for small coal banks.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 1, 1903.

DEAR SIR: In accordance with the act of Congress of March 6, 1902, requiring the Director of the Census to prepare a report on mines and quarries, and pursuant to an agreement between the Director of the Census and the Director of the United States Geological Survey, the Geological Survey will collect the data for the mining census, in addition to the usual information collected for the annual report, "Mineral Resources of the United States." The schedule below has been prepared for the purpose of obtaining the statistics of the production of small coal banks which are engaged in mining coal for immediate local consumption. Please fill out the replies to all the inquiries and return this schedule in the accompanying envelope, which requires no postage.

In order that reports from all local banks may be secured, and the canvass thus be made as complete as possible, you are requested to add the names of the owners of any other mines in your immediate vicinity.

Your prompt compliance with this request will greatly facilitate the work of both the Geological Survey and the Census Office, and will be highly appreciated.

Very respectfully,

CHAS. D. WALCOTT, *Director.*

Name........
Post office........
County........
State........

Quantity of coal produced in 1902:

Tons ....
Bushels........
Total value of the same at the mine........ $........
Total cost of supplies and materials used at the mine in 1902 .... $........
Total amount paid in wages during the year .... $........
Total number of men employed at the mine during the year........
Total number of days the mine was worked during the year........

Please give below the names of owners of other small coal mines in your vicinity. (Other names may be added on the back of this sheet.)

NAME.	Post office.	State.

Special Schedule No. 9.—For petroleum and natural gas wells. (*Number printed, 20,000.*)

First page same as Schedule No. 6.

Inquiries 1 and 2 same as Schedule No. 6.

3. Persons employed.

CLASSES.	Average number employed during the year.	Total amount paid in wages or salaries during the year.
General officers		$
Superintendents, managers, foremen, etc.		
Clerks		
Engineers, firemen, machinists, blacksmiths, drillers, rig builders, pumpmen, and other mechanics		
Boys under 16 years		
All other employees		
Total		$

(Account for all persons employed at the wells. Give the total salaries and wages paid, which should include board or rent furnished as part compensation. Stockholders of corporations are not to be reported unless they are salaried officials. Amounts paid for contract work, not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but be reported in answer to Inquiry 5. The average number employed during the year is the number that would be required, at continuous employment for the twelve months, to produce the quantity of product reported.)

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.

OCCUPATIONS.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
Engineers and pumpmen																	
Firemen																	
Machinists, blacksmiths, drillers, rig builders, and other mechanics																	
Boys under 16 years																	
All other employees, not including those on salaries																	

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH

MONTH.	Men 16 years and over.	Boys under 16 years.	MONTH.	Men 16 years and over.	Boys under 16 years.
January			July		
February			August		
March			September		
April			October		
May			November		
June			December		

(Only wage-earners should be reported. Do not include firm members, general officers superintendents, managers, foremen, clerks, and other salaried employees.)

Inquiry 4 same as Inquiry 5 on Schedule No. 6.

5. Contract work.

Amount paid, if any, for well drilling, rig building, etc., if not done by employees hired directly by this establishment, $..........

Average number of men employed on such work..........

Number of days employed..........

6. Supplies and materials:

Total cost of supplies and materials of all kinds used during the year, including freight paid on the same, $..........

(The actual cost of all supplies and materials used during the year, including freight paid on the same, must be reported. The cost of the following materials should be reported under this inquiry: Lumber and timber used for repairs, rig building, and all other purposes; iron and steel for blacksmithing, parts of machinery and tools used for renewals and repairs; explosives, water for boilers and for other purposes, fuel, machinery supplies, etc.)

7. Miscellaneous expenses:

ITEMS.	Amount.
Royalties and rent of wells	$
Amount paid for rent of offices, taxes, insurance, interest, advertising, office supplies, law expenses, telegraph and telephone service, and all other sundries not reported elsewhere	
Total	$

(All items of expense incident to the operation of the wells not accounted for under Inquiries 3, 5, and 6, must be reported here. Do not include any portion of the freight reported under Inquiry 6 as paid on supplies and materials

8. Product

Total quantity of petroleum produced during the year (barrels of 42 gallons)..........

Total value, at wells, of petroleum produced during the year .... $..........

Total value, at wells, of natural gas produced during the year.... $..........

(Under this inquiry should be reported the quantity and value of petroleum and the value of natural gas produced during the year, at the wells, as reported to the United States Geological Survey.)

Inquiry 9 same as Inquiry 10 on Schedule No. 6.

10. Tankage:

Number of tanks at wells ......; total capacity, in barrels of 42 gallons ......

11. Wells:

Total number of wells drilled during the year ......; number of producing wells drilled during the year ......; number of dry holes drilled during the year ......

Of the total number of wells reported on this schedule, state the number flowing ......; number pumping ......; and the number abandoned during the year, ...

What diminution of pressure has occurred during the year? (Describe fully.)

Special Schedule No. 10.—For gold, silver, lead, and copper mines. (*Number printed, 78,000.*)

First page same as Schedule No. 6, except that the following note of instructions is printed after the location and post office address of the mine:

Where a mine and reduction works are operated under the same management, separate reports should be made on each Schedule No. 10 and No. 11, respectively. If this is not possible, a full report should be made on this schedule (with the exception of Inquiry 10), covering both the mine and reduction works, and answers should also be given to Inquiries 4, 5, 9, 10, and 12 on Schedule No. 11.

Inquiry 1 same as Schedule No. 6.

2. If this mine was ever abandoned, state year when last abandoned .... and when last reopened ....

Inquiries 3, 4, 5, and 6, same as Inquiries 2, 3, 4, and 5, on Schedule No. 6.

7. Contract work:

a. Amount paid, if any, for work not done by employees hired directly by this establishment, $........

State whether drainage, pumping, tunneling, shaft sinking, boring test holes, etc. ....

Average number of men employed on such work......

Number of days employed......

b. Total amount received for contract work done for other establishments, $........ State whether tunneling, drainage, pumping, etc..........

(Do not include charges for treatment of ores, tailings, etc., at custom mills.)

Inquiry 8 same as Inquiry 7 on Schedule No. 6.

9. Miscellaneous expenses:

ITEMS.	Amount.
Amount expended in development work	$
Rent and royalties of mine and mineral land	
Rent of mining plant and improvements	
Rent or royalty for tunnel privileges	
Water rent	
Other rent or royalties (specify kind)	
Amount paid for taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere	
Total	$

(All items of expense incident to the operation of the mine, not accounted for under Inquiries 4, 6, 7, and 8, must be reported here. Do not include any portion of the freight reported under Inquiry 8 as paid on supplies and materials. The items of rent should be stated separately only in cases where they are paid separately; if any two or more of them are paid in one sum, for instance royalties for mine and mining plant, the fact should be stated and the one amount paid should be given, without attempting to make a division.)

10. Product:

Gross value of metallic contents, as reported to the United States Geological Survey .... $..............

Deductions:

Charges for treatment, per ton, $........; total.......... $..............

Freight, per ton, $........: total........................ $..............

Net value of mining product.................................. $..............

11. Name and address of mill or works at which the ore is treated, ...

By what method is the ore conveyed from the mine to the mill?............

12. Mineral lands:

Total acreage—owned ....; held on lease ....; leased to other parties .....

If worked by dredges, state total area treated in 1902, acres ....

13. Water plant:

Total length of ditches owned (including flumes, pipes, etc.), miles, ...; feet, ...

14. Length of railroad tracks owned:

On the surface ....

Underground ....

Inquiry 15 same as Inquiry 10 on Schedule No. 6.

16. Machinery:

CLASS OF MACHINE.	Kind of power.	Number.
Hoisting engines		
Pumping engines		
Locomotives for outside or inside haulage		
Power drills		
Steam shovels or derricks		
Dredges		

Special Schedule No. 11.—For reduction works (*other than smelters*). (*Number printed, 11,500.*)

First page same as Schedule No. 6.

Inquiries 1 and 2 same as Schedule No. 6.

3. Persons employed:

CLASSES.	Average number employed during the year.	Total amount paid in wages or salaries during the year.
General officers		$...........
Superintendents, managers, foremen, assayers, etc.		
Clerks		
Engineers, firemen, machinists, blacksmiths, carpenters, and other mechanics		
Boys under 16 years		
All other employees		
Total		$...........

(Account for all persons employed at the works. Give the total salaries and wages paid, which should include board or rent furnished as part compensation. Stockholders of corporations are not to be reported unless they are salaried officials. The average number employed during the year is the number that would be required, at continuous employment for the twelve months, to produce the quantity of product reported.)

AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY.

OCCUPATIONS.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
Engineers																	
Firemen																	
Machinists, blacksmiths, carpenters, and other mechanics																	
Boys under 16 years																	
All other employees, not including those on salaries																	

AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH.

MONTH.	Men 16 years and over.	Boys under 16 years.	MONTH.	Men 16 years and over.	Boys under 16 years.
January			July		
February			August		
March			September		
April			October		
May			November		
June			December		

(Only wage-earners should be reported. Do not include firm members, general officers, superintendents, managers, foremen, clerks, and other salaried employees.)

Inquiry 4 same as Inquiry 5 on Schedule No. 6.

5. Amount paid, if any, for treatment of bullion, concentrates, tailings, or other products at custom smelters, refineries, or other custom works, $........

Total freight paid on the same, $........

6. Materials:

State character of materials used, whether ore, tailings, or other materials, ...

Total assay contents and value of all materials bought in 1902:

	Total assay contents.	Value.		Value.
Gold, ounces fine		$.......	Total gross value (brought forward)	$.......
Silver, ounces fine			Deductions:	
Lead, pounds			Total working charges	$.......
Copper, pounds			Total freight	$.......
Other metals, pounds			Total deductions	$.......
Total gross value		$.......	Net paid	$.......

(Under this inquiry should be given the cost of all materials bought for the mill. State the metallic contents of the ore, etc., as per sample or assay; the value allowed for gold, silver, lead, copper, and other metals contained in the materials; the deductions made to cover working charges and freight; and give the total net amount paid. Do not give under this inquiry the yield in gold, silver, and other metals resulting from the treatment of the materials at the works and reported to the Geological Survey.)

7. Supplies:

Total cost of mill supplies of all kinds used during the year, including freight paid on the same, $........

(The cost of the following supplies should be reported under this inquiry: Shoes, dies, screens, plates, and other parts of machinery and tools used for renewals and repairs; quicksilver, cyanide of potassium, lumber, iron, steel, oil, fuel, water, etc.)

8. Miscellaneous expenses:

Amount paid for rent of offices, plant, and land, taxes, insurance, interest advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere. $........

(All items of expense incident to the operation of the works, not accounted for under Inquiries 3, 5, 6, and 7, must be reported here. Do not include freight.)

9. Product:

Gross value of metallic contents, as reported to the United States Geological Survey .... $........

Deductions on product sold (not including product of this establishment treated at custom works):

Total smelter charges .... $........

Total freight .... $........

Net value of milling product at the mill .... $........

10. Custom work done by this establishment.

	Ore.	Concentrates or other material.	Tailings.	Total.
Quantity treated, tons				
Amount received, not including freight	$......	$......	$......	$......
Freight paid on the same	$......	$......	$......	$......

Inquiry 11 same as Inquiry 10 on Schedule No. 6.

12. Name, location, and character of establishment to which the product was sold or shipped for final treatment:

Gold bullion........

Silver bullion........

Concentrates........

Other products (specify kind)........

In addition to the foregoing schedules, Nos. 10 and 11, for mines and reduction works, a schedule was printed for smelters and refineries. Smelters and refineries were included in the Census of Manufactures taken in 1900 and did not come within the scope of the Census of Mines and Quarries of 1902. This schedule was provided for the purpose of merely verifying the reports of the metallic contents of the ores mined and the cost of reduction, and of ascertaining the terms upon which ores were treated by custom smelters, the cost of smelting and refining, and the percentage of metals recovered in the process.

Special schedule No. 12.—For smelters and refineries. (*Number printed 1,000.*)

United States Census Office.
Special Schedule No. 12.

DIVISION OF MANUFACTURES.
S. N. D. North, Chief Statistician.

SMELTERS AND REFINERIES.

Name of works........

Character of works........

Name of company, firm, or individual owner........

Location of works: City or town........; County........; State........

General office at........

Isaac A. Hourwich, Ph. D., of Washington, D. C., has been appointed expert special agent of the Census Office for this branch of the inquiry.

1. Date of establishment of works........

2. If a corporation, in which state incorporated? ....
Year of organization........

3. Schedule of prices paid for materials treated in 1902:

	Ores.	Concentrates.	Matte.	Bullion.	Miscellaneous.
Gold, per ounce	$......	$......	$......	$......	$......
Silver, percentage paid					
Lead, per unit (state what unit)	$......	$......	$......	$......	$......
Lead, percentage paid					
Copper, per unit (state what unit)	$......	$......	$......	$......	$......
Other metals (specify each kind)					
Deductions.					
Working costs, per ton	$......	$......	$......	$......	$......
Freight, per ton					

Specify classes of materials embraced under the head of "Miscellaneous"........

(State separately prices paid per ounce of gold contained in ores, concentrates, matte, bullion, or other materials; likewise state separately percentage of silver contents paid for in each class of materials, give the unit of lead and copper paid for, whether pound or percentage, contained in ore, concentrates, etc. If working costs per ton vary with the character of ore, give all rates in detail.)

4. If the smelter is in a mining district, state by what method the ore is conveyed from the mine to the smelter:........

5. Total daily capacity of plant, tons per 24 hours........

6. Time in operation:

Total number of days in operation during the year 1902........, number of hours in operation per day........

7. Total amount paid in salaries and wages during the year 1902, $........

8. Cost of supplies used during the year, including freight paid on the same, $........

(The cost of the following supplies should be given under this inquiry: Parts of machinery and tools used for renewals and repairs, fuel, fluxes, zinc, oil, and all other supplies consumed in the running of machinery.)

9. Miscellaneous expenses, $........

(Amount paid for rent of land, buildings, machinery, offices, taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere.)

10. Production of smelter, not including custom work.

MATERIALS TREATED.	Ores.	Concentrates.	Matte.	Bullion.	Miscellaneous.
Quantity, tons or pounds					
Total contents as per assay before smelting:					
Gold, ounces fine					
Silver, ounces fine					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

BULLION RECOVERED.	From ores.	From concentrates.	From matte.	From bullion.	From miscellaneous.
Gold, ounces fine					
Silver, ounces fine					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

Specify classes of materials embraced under the head of "Miscellaneous"........

(Give the total quantity, in tons or pounds, of each class of materials treated and the assay contents of ores, concentrates, matte, bullion, etc., separately, also the bullion recovered from each class of materials—that is, the gold, silver, lead, copper, or other metallic contents of the smelted product, as shown by assay.)

11. Production of refinery, not including custom work.

	CRUDE BULLION TREATED		Refined bullion produced, fine weight.
	Gross weight.	Fine weight as shown by assay.	
A. Materials from smelting department.			
Gold, ounces			
Silver, ounces			
Lead, pounds			
Copper, pounds			
Other products, pounds (specify each kind)			
B. Materials bought.			
Gold, ounces			
Silver, ounces			
Lead, pounds			
Copper, pounds			
Other products, pounds (specify each kind)			

12. Custom smelting. (See instructions under Inquiry 10.)

MATERIALS TREATED.	Ores.	Concentrates.	Matte.	Bullion.	Miscellaneous.
Quantity, tons or pounds					
Total contents as per assay before smelting:					
Gold, ounces fine					
Silver, ounces fine					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

BULLION RETURNED.	From ores.	From concentrates.	From matte.	From bullion.	From miscellaneous.
Gold, ounces fine					
Silver, ounces fine					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					
Total smelting charges	$	$	$	$	$
Total freight charges					

Is freight charged to the customer?..........

Specify classes of materials embraced under the head of "Miscellaneous":...

13. Custom refining:

	CRUDE BULLION TREATED.		Refined bullion returned (fine weight).	Total tolls received.	Total freight charged.
	Gross weight.	Fine weight as per assay.			
Gold, ounces				$	$
Silver, ounces					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

14. Crude bullion treated at other refineries.

	CRUDE BULLION SHIPPED.		Refined bullion received (fine weight).	Total tolls paid.	Total freight paid.
	Gross weight.	Fine weight as per assay.			
Gold, ounces				$	$
Silver, ounces					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

15. Crude bullion sold.

	Gross weight.	Fine contents.	Total gross value.	Refining charges.	Freight charges.
Gold, ounces			$	$	$
Silver, ounces					
Lead, pounds					
Copper, pounds					
Other metals, pounds (specify each kind)					

16. Name and location of mint, assay office, or refinery to which bullion was shipped during the year.

Gold ....

Silver ....

Lead ....

Copper ....

Before commencing the mining census it was considered necessary to prepare a schedule for corporations, firms, or individuals operating more than one mine or quarry with a central office for all of them.

Special schedule, No. 6a.—Supplemental schedule for administrative and general offices. (*Number printed, 12,000.*)

UNITED STATES CENSUS OFFICE.

Special Schedule, No. 6a.

DIVISION OF MANUFACTURES.

S. N. D. NORTH, Chief Statistician.

MINES AND QUARRIES.

SUPPLEMENTAL SCHEDULE FOR ADMINISTRATIVE AND GENERAL OFFICES.

Name of company, firm, or individual owner ....

General office, State.......... County.......... City or town..........

Corporations, firms, or individuals operating more than one mine, quarry, or reduction works, with a central office for all of them, are requested to report on this schedule the employees of such central office, with their salaries or wages, and all other employees whose work is not confined to one particular mine, quarry, or reduction works, such as general superintendents, machinists, surveyors, etc. All general expenses are also to be reported on this schedule, and the data relating to capital stock, bonds, dividends, and assessments of incorporated companies. No data reported on this schedule should appear on the separate reports for the individual mines, quarries, or reduction works. Separate schedules are supplied for these individual plants.

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief.

....
(Signature and official designation of the person furnishing the information.)

....
(Signature of special agent.)

1. Character of present organization, whether individual, firm, limited partnership, cooperative association, or incorporated company: ....

2. Capital stock, bonds, dividends, and assessments (if an incorporated company):

	BONDS.		PREFERRED STOCK.		COMMON STOCK.	
	Number.	Total par value.	Number of shares.	Total par value.	Number of shares.	Total par value.
Authorized........	......	$.....	......	$.....	......	$.....
Issued to end of the year........	......	$.....	......	$.....	......	$.....

Dividends and interest, if any, paid during the year:
Common stock, rate..................................; amount, $.........
Preferred stock, rate..................................; amount, $.........
Bonds, rate..................................; amount, $.........
Assessments: Total amount levied since organization of company.. $...........

3. Persons employed:

CLASSES.	Average number employed during the year.	Total amount paid in salaries or wages during the year.
General officers........	....	$..........
Other officers (managers, general superintendents, etc.)........	....	....
Clerks........	....	....
Surveyors, machinists, laborers, and all others not employed at particular mines, quarries, or reduction works........	....	....
Total........	....	$..........

(Account for all persons not included in the separate returns for mines, quarries, or reduction works. Give the total salaries and wages paid, which should include board or rent furnished as part compensation. Stockholders of corporations are not to be reported, unless they are salaried officials. Amounts paid for contract work, not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but be reported in answer to Inquiry 4. The average number employed during the year is the number that would have continuous employment for the twelve months.)

4. Contract work:

Amount paid, if any, for tunneling, shaft sinking, boring test holes, etc., not chargeable to a particular mine or quarry, if not done by employees hired directly by this establishment .... $..........

Average number of men employed on such work............

Number of days employed...........

5. Miscellaneous expenses:

Amount paid for rent of offices, taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere .... $..........

(All items of general expense not accounted for under Inquiries 3 and 4 must be reported here.)

6. Names and locations of mines, quarries, or reduction works owned or leased: (If not sufficient space, use separate sheet of paper.)

NAME OF MINE, QUARRY, OR REDUCTION WORKS.	LOCATION. State.	County.	Nearest city or town.
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Special Schedule No. 6b.—For stone quarries in addition to Special Schedule No. 6, as supplementary thereto. (*Number printed, 35,000.*)

UNITED STATES CENSUS OFFICE.

Special Schedule No. 6b.

(To be filled out and returned in connection with and in addition to Special Schedule No. 6, as supplementary thereto.)

DIVISION OF MANUFACTURES.
S. N. D. NORTH, Chief Statistician.

STONE QUARRIES.

Name of quarry ....

Kind of stone..

Name of company, firm, or individual owner..................................

Location of quarry: State........................; County..................

Nearest city or town.....................; Post office.......................

Dr. G. P. Merrill, of the United States National Museum, has been appointed expert special agent of the Census Office for the collection of statistics relating to stone quarries.

QUARRYING AND STONE-DRESSING MACHINES.

(Please state the kinds of drills, channellers, gadders, and quarry bars used, and if other machines than those specified below are used, please report them and give full description in the blank spaces provided.)

KIND.	Trade name and make.	Number used.	Year when adopted.
Drills........	....	......	......
Channellers........	....	......	......
Gadders........	....	......	......
Quarry bars........	....	......	......
Helicoidal saws ?........	....	......	......
Reciprocating saws used with sand, chilled iron, or crushed steel, in gangs........	....	......	......
Reciprocating saws with diamond teeth........	....	......	......
Planers........	....	......	......
Lathes........	....	......	......
Rubbing beds........	....	......	......
Polishers........	....	......	......
Surfacing machines........	....	......	......
Jointing machines........	....	......	......
Sand-blast machines........	....	......	......
All others........	....	......	......

There were provided in addition to the schedules of the Census Office, copies of the schedules of the Geological Survey which were used for transcribing the information reported to that office.

No. ......

UNITED STATES CENSUS OFFICE.

DIVISION OF MANUFACTURES.

MINES AND QUARRIES.

SLATE. (*Number printed, 500.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner..................................

General office ....

Location of quarry: State........................; County..................

Nearest city or town ....

1. Please give quantity of slate sold and selling value at the quarry for the year 1902, as follows:

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Roofing slate (squares)		$
Milling stock and all other purposes		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with the preceding year?

Note carefully the following:

Unless statements of tests or analyses of your slate have been given with previous replies, you are earnestly requested to give the results of any such analyses or tests, with the name of the expert who made the analysis or test.

Please give the names and addresses of any new quarry operators in your vicinity.

If you have retired permanently from the business or did not operate last year, please so state.

MARBLE. *Number printed, 500.*

Special Schedule No. 6.

Name of quarry

Name of company, firm, or individual owner

General office

Location of quarry: State County

Nearest city or town

1. Please give quantity of marble quarried and the value at the quarry for the year 1902, as follows:

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Sold rough for—		
Building purposes		$
Monumental work		
Other purposes		
Dressed for—		
Building purposes		
Monumental work		
Ornamental purposes		
Interior decoration		
Other purposes		
Other uses [State use, if possible.]		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following:

Unless statements of tests or analyses of your marble have been given with previous replies, you are earnestly requested to inclose the results of any such analyses or tests, with the name of the expert who made the analysis or test.

If you have retired permanently from the business, or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

TRAP ROCK. *Number printed, 500.*

Special Schedule No. 6.

Name of quarry

Name of company, firm, or individual owner

General office

Location of quarry: State County

Nearest city or town

1. Please give quantity of trap rock quarried and the value at the quarry for the year 1902, as follows:

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Sold rough for building purposes		$
Dressed for building purposes		
Made into paving blocks		
Crushed stone for—		
Roadmaking (macadam, etc.)		
Railroad ballast		
Concrete, etc.		
Rubble		
Riprap		
Other purposes [State purpose, if possible.]		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following:

Unless statements of tests or analyses of your trap rock have been given with previous replies, you are earnestly requested to inclose the results of any such analyses or tests, with the name of the expert who made the analysis or test.

If you have retired permanently from the business, or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor, and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

GRANITE. *Number printed, 2,000.*

Special Schedule No. 6.

Name of quarry

Name of company, firm, or individual owner

General office

Location of quarry: State County

Nearest city or town

1. Please give quantity of granite quarried and the value at the quarry for the year 1902, as follows:

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Sold rough for—		
Building purposes		$
Monumental work		
Other purposes		
Dressed for building purposes		
Dressed for monumental work		
Dressed for interior decoration		
Made into paving blocks		
Curbing		
Flagging		
Crushed stone for—		
Roadmaking (macadam, etc.)		
Railroad ballast		
Concrete, etc.		
Rubble		
Riprap		
Other purposes [State purpose, if possible.]		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following:

Unless statements of tests or analyses of your granite have been given with previous replies, you are earnestly requested to inclose the results of any such analyses or tests with the name of the expert who made the analysis or test.

If you have retired permanently from the business, or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

SANDSTONE. (*Number printed, 1,750.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State ....; County ....

Nearest city or town ....

1. Please give quantity of sandstone quarried and the value at the quarry for the year 1902, as follows.

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Sold rough for building purposes		$
Dressed for building purposes		
Crushed stone for—		
Roadmaking (macadam, etc.)		
Railroad ballast		
Concrete, etc		
Ganister rock		
Riprap		
Rubble		
Paving		
Flagging		
Curbing		
Grindstones		
Whetstones		
Sand mined:		
Glass sand		
Engine sand		
Furnace sand		
Building sand		
Other uses		
Other purposes [state purpose, if possible.]		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following:

Unless statements of tests or analyses of your sandstone have been given with previous replies, you are earnestly requested to inclose the results of any such analyses or tests, with the name of the expert who made the analysis or test.

If you have retired permanently from the business or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor, and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

BLUESTONE. (*Number printed, 500.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry. State ....; County ....

Nearest city or town ....

1. Please give quantity of bluestone quarried and the value at the quarry for the year 1902, as follows.

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Sold rough for building purposes		$
Dressed for building purposes		
Crushed stone for—		
Roadmaking (macadam, etc.)		
Railroad ballast		
Concrete, etc		
Riprap		
Rubble		
Paving		
Flagging		
Other purposes [State purpose, if possible.]		
Total value		$

2. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following.

Unless statements of tests or analyses of your bluestone have been given with previous replies, you are earnestly requested to inclose the results of any such analyses or tests, with the name of the expert who made the analysis or test.

If you have retired permanently from the business, or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

LIMESTONE. (*Number printed, 7,599.*)

Special Schedule No. 8.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State ....; County ....

Nearest city or town ....

1. Please give quantity of limestone quarried and the value at the quarry for the year 1902, as follows.

[Give your usual unit of measurement, but state definitely what it is.]

	Quantity.	Value.
Building purposes		$
Flagging		
Curbing		
Stone burned into lime		
Lime made [Give quantity and value of lime in bulk.]		
Stone sold as such to lime burners		
Crushed stone for—		
Roadmaking (macadam, etc.)		
Railroad ballast		
Concrete, etc		
Rubble		
Riprap		
Blast-furnace flux		
Quarried for cement		
Other purposes [State purpose, if possible.]		
Total value		$

2. What was the average price of lime per bushel or barrel in your locality during 1902?

3. How was the demand and what was the general condition of trade in 1902 as compared with 1901?

Note carefully the following:

Unless statements of tests or analyses of your limestone, or the lime made from it, have been given with previous replies, you are earnestly requested to inclose the results of any such tests or analyses, with the name of the expert who made the analysis or test.

If you have retired permanently from the business or have not operated in 1902, please so state.

If you have disposed of your quarry, please give the name and address of your successor, and the date on which you sold.

If you have recently acquired your quarry, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of any new quarry operators in your vicinity.

BARYTES. (*Number printed, 800.*)

Special Schedule No. 6.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State ....; County ....

Nearest city or town ....

Inquiries for miners.

Quantity of crude barytes produced in 1902, short tons ....

Total value at the mine .... $..........

[If any part of the above product was purchased from other parties, please state under "Remarks" the names of such parties and the quantity obtained from each.]

Inquiries for manufacturers.

Quantity of barytes treated by you in 1902, short tons ....

Quantity of refined product, as follows:

Floated for pigment, short tons ....

For canvasing barns, etc., short tons ....

For other purposes, short tons ....

Value of refined product .... $..........

Please state from what locality your crude material was obtained: ....

What was the tendency of trade as compared with preceding year?

Please note the names and addresses of any new operators in your vicinity.

REMARKS.

MINERAL PAINTS. (*Number printed, 1,000.*)

Special Schedule No. 6.

Name of mine or works ....

Name of company, firm, or individual owner ....

General office ....

Location of mine or works: State ....; County ....

Nearest city or town ....

Please fill out the following blanks with the quantity and value of your production in 1902. It is preferred to have returns made for "dry ground" paint. If you sell in any other condition, please state what it is.

	Quantity (short tons).	Value.
Metallic paint	....	$..........
Mortar colors	....	....
Ocher	....	....
Umber	....	....
Sienna	....	....
Soapstone	....	....
Barytes	....	....
Slate	....	....
Venetian reds	....	....
Zinc white	....	....
Other pigments	....	....

Please note any changes in the condition of trade as compared with the preceding year.

Please give the names and addresses of any new operators in your vicinity.

REMARKS.

MICA. (*Number printed, 250.*)

Special Schedule No. 6.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State ....; County ....

Nearest city or town ....

What was your production in 1902?

	Quantity.	Value.
Cut or sheet mica .... pounds..	....	$...
Scrap or waste .... short tons..	....	....

What were the uses for which it was sold? Please make an estimate if you have no exact figures.

Uses.	Quantity.
Stove .... pounds..	....
Electrical .... pounds..	....
Ground for—	
Lubricants .... short tons..	....
Wall papers .... short tons..	....
Other purposes .... short tons..	....

How many days was your mine worked in 1902?

Please note the names and addresses of any new operators in your vicinity.

REMARKS.

PHOSPHATE ROCK. (*Number printed, 1,250.*)

Special Schedule No. 6.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State ....; County ....

Nearest city or town ....

What was the quantity and value of your product in 1902?

[Please state definitely whether long or short ton is used......]

	Total quantity produced in 1902. .... tons.	Total quantity sold in 1902. .... tons.	Value of sales.
Land rock	....	....	$..........
River rock	....	....	....
Hard rock	....	....	....
Soft rock	....	....	....
Plate rock	....	....	....
Land pebble	....	....	....
River pebble	....	....	....
White rock	....	....	....
Blue rock	....	....	....
Brown rock	....	....	....
Total	....	....	$..........

Answers to above queries are requested from *producers* of phosphate rock only. If the person addressed is a merchant or agent, buying and selling phosphates or phosphate lands, and not engaged in mining, please return this card with a statement to that effect.

Please give the names and addresses of any new operators in your vicinity.

REMARKS.

GYPSUM AND GYPSUM PRODUCTS. (*Number printed, 500.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State ....; County ....

Nearest city or town ....

Source of gypsum.

	Short tons.	Value.
Quantity quarried		$
Quantity purchased locally		
Quantity imported		
Total value		$

Disposal of gypsum.

	Short tons.	Value.
Quantity sold crude		$
Quantity sold as land plaster		
Quantity sold as wall or cement plaster		
Quantity sold as plaster of Paris		
Total value		$

What was the condition of trade as compared with that of the preceding year? Please note the names and addresses of any new operators in your vicinity, and add any other information which the blank does not furnish space for.

REMARKS.

EMERY AND CORUNDUM. (*Number printed, 100.*)

Special Schedule No. 6.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State .... County ....

Nearest city or town ....

Emery.

	Short tons.
1. Total quantity of emery mined in 1902	
2. Total quantity of emery sold in 1902	
3. Total value of emery sold	$

Corundum.

	Short tons.
4. Total quantity mined in 1902	
5. Total quantity sold in 1902	
6. Total value of corundum sold	$

NEW ADDRESSES.

Please give the names of any other operators in your vicinity.

REMARKS.

MILLSTONES. (*Number printed, 100.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State .... County ....

Nearest city or town ....

1. Total number of millstones made by you in 1902 ....
2. Total number sold in 1902 ....
3. Total value of millstones sold in 1902 .... $ ....
4. Please state how many of each size you made and what was the average price per pair.

	Number made.	Price per pair.
30 inches		$
36 inches		
42 inches		
48 inches		

5. What was the condition of trade as compared with the previous year?

Please give the name and address of any new manufacturer of millstones in your vicinity.

REMARKS.

GRINDSTONES. (*Number printed, 150.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State .... County ....

Nearest city or town ....

	Short tons.
1. Total approximate quantity of crude rock quarried in 1902. [This question applies only to stone quarried for the manufacture of grindstones.]	
2. Total number of grindstones made in 1902	
3. Total number of grindstones of your own make sold by you in 1902. [In replying to questions 2 and 3, please state definitely whether your product is sold by weight or otherwise.]	
4. Total value of grindstones sold in 1902	$

5. Please give average prices for different sizes of grindstones during the year. Please note the names of any other manufacturers in your vicinity.

REMARKS.

SOAPSTONE AND TALC. (*Number printed, 250.*)

Special Schedule No. 6.

Name of quarry ....

Name of company, firm, or individual owner ....

General office ....

Location of quarry: State ....; County ....

Nearest city or town ....

Total quantity of {soapstone / talc} produced by you in 1902 (short tons) ....

Quantity sold in rough state as quarried (short tons) ....

Total value of same .... $ ....

Quantity sawed into slabs and sold (short tons) ....

Total value of slabs sold .... $ ....

Quantity made by you into washtubs, laboratory or kitchen sinks, stove bricks, griddles, or other mill stock (short tons) ....

Total value of manufactured articles .... $ ....

Quantity ground for paint, paper filling, complexion powders, lubricants, etc. (short tons) ....

Value after grinding .... $ ....

Information regarding any further uses to which your product is put, the condition of trade, new developments, etc., will be greatly appreciated.

Please note the causes of any notable fluctuations, either in amount or value, of your production as compared with the preceding year. This should include fires or other accidents, strikes, new advantages in transportation facilities, favorable freight rates, etc.

BITUMINOUS COAL. (*Number printed 10,000.*)

Special Schedule No. 8.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State ....; County ....

Nearest city or town ....

Character of coal produced ....

Disposition of product. [Include all marketable sizes of coal. Exclude only slack coal wasted.] Tons

Loaded at mines for shipment

Sold to local trade or used by employees

Used at mines for steam and heat

Made into coke at mines

Total production in 1902

Please state definitely whether "long" or "short" ton is used by you

Total selling value of product $

Average price per ton $

Average number of full days made by each employee (exclusive of coke workers) during the year. (Parts of days should be reduced to equivalent in full days)

Average number of employees during the year, including all persons connected directly with the mine, but excluding coke workers

If the mine reported hereon was idle because of strikes in 1902, please state how many men were affected and how many days they were idle.

Ans.: Number of men on strike

Number of days idle

Date of strike: From to

Mining machines.

Do you use any machines for mining coal? Ans.:

How many were in use in 1902? Ans.:

How many tons of your product were mined by machines in 1902? Ans.:

Kinds of machines used.

Pick machines: Number.

- Harrison
- Sullivan
- Ingersoll-Sargeant
- Other kinds

Chain breast machines:

- Jeffrey air
- Jeffrey electric
- Independent or Link-Belt
- Morgan-Gardner
- Morgan Standard
- Other kinds

Long wall:

- Jeffrey
- Sperry
- Lee
- Other kinds

ANTHRACITE COAL. (*Number printed, 500.*)

Special Schedule No. 8.

Name of mine

Name of company, firm, or individual owner

General office

Location of mine: State , County

Nearest city or town

Disposition of product: Long tons

Loaded at mine for shipment

Sold to local trade or used by employees

Used at mine for steam and heat

Total production in 1902

Total selling value of product $

Average price per ton $

Railways over which product was shipped

Average number of full days made by each employee during the year. (Parts of days should be reduced to equivalent in full days.)

Average number of employees during the year, including all persons connected directly with the mine

If the mine reported hereon was idle because of strikes in 1902, please state how many men were affected and how many days they were idle.

Ans.: Number of men on strike

Number of days idle

Date of strike: From to

REMARKS.

CLAY. (*Number printed, 750.*)

Special schedule No. 6.

Name of mine

Name of company, firm, or individual owner

General office

Location of mine: State ; County

Nearest city or town

☞ In compiling these statistics the amount of sales during the year 1902 is what is desired, not including clay burned by yourself. By "value" is meant the net price at the mine f. o. b. cars, wagons, or boats.

Clay mined and sold in 1902.

	Quantity (tons of 2,000 pounds).	Value.
Kaolin:		
Raw		$
Ground, washed, or prepared in any way		
Ball clay:		
Raw		
Ground, washed, or prepared in any way		
Fire clay:		
Raw		
Ground, washed, or prepared in any way		
Stoneware clay:		
Raw		
Ground, washed, or prepared in any way		
Pipeclay:		
Raw		
Ground, washed, or prepared in any way		
Terra cotta clay:		
Raw		
Ground, washed, or prepared in any way		
Miscellaneous clay (please give variety):		
Raw		
Ground, washed, or prepared in any way		
Total mined and sold by you in 1902		

[If there have been any analyses made of your clay which you have not already sent to this office, please inclose copies with this slip.]

Please give the color to which your clay burns.

If you are also engaged in the burning of clay, please so state.

If you have retired permanently from the business, or made no sales of clay in 1902, please so state.

If you have disposed of your mine, please give the name and address of your successor, and the date on which you gave possession.

If you have recently acquired your mine, please give the name of its former owner and the date on which you took possession.

Please give the names and addresses of the operators of any new clay mines in your neighborhood.

CEMENT. (*Number printed, 250.*)

Special Schedule No. 6.

Name of quarry

Name of company, firm, or individual owner

General office

Location of quarry: State , County

Nearest city or town

Quantity.

Natural cement made in 1902 (barrels)

Portland cement made in 1902 (barrels)

- Limestone quarried in 1902
- Limestone purchased in 1902
- Marl mined in 1902
- Marl purchased in 1902

Slag cement made in 1902 (barrels)

Please state how many kilns you use.

Number.

Vertical

Rotary

Please give the location of your office.

Please give the location of your factory.

If your plant was idle during the past year, please state that fact.

If you have disposed of your business, or retired, please state such facts and give the name of your successor, if any.

Please give the names of any new cement works established or projected in your neighborhood.

PRECIOUS METALS AND DEEP MINES. *(Number printed, 35,000.)*

Special Schedule No. 10a.

Name of mine

Name of company, firm, or individual owner

General office

Location of mine: state County

Nearest city or town

Mining district or region

Name and address of superintendent

	Tons of 2,000 pounds.
1. Total quantity of ore mined in 1902	
2. Total quantity of ore sold or treated in 1902	
3. Stock of ore on hand December 31, 1901	
Stock of ore on hand December 31, 1902	

4. Total bullion contents of above ore sold or treated in 1902:

	Fine ounces.	Value.
Gold		$
Silver		
	Pounds.	
Copper		
Lead		
Other metals		
Total value		$

5. What is the prevailing mineralogical character of your ore? [For instance, auriferous pyrite, argentiferous galena, copper glance passing into chalcopyrite, etc.]
6. What is the geological character of your deposit? [For instance, fissure vein in granite, blanket deposit in limestone, contact deposit between limestone and porphyry, etc.]
7. How is your mine opened, and what is the extent of the workings? [For instance, by vertical shaft —— feet deep, by tunnel —— feet long, etc.]
8. By what process or processes is your ore reduced to the metallic state? [Smelting, amalgamation, chlorination, cyaniding, etc.]
9. If returns are from a number of mines or mining claims operated under one direction or management, please give names and localities of the same.
10. If ores are treated at reduction works owned or operated by the company, please state the process:

    a. Concentration only

    b. Stamp mill and concentration

    c. Chlorination

    d. Cyanide

    e. Give any peculiarities in your process or mode of treatment

11. Bullion contents and gross value per ton of ore sold or treated

Gold, fine ounces	
Silver, fine ounces	
Copper, per cent	
Lead, per cent	
Other metals, per cent	
Aggregate gross value	$

12. Increase or decrease of stock of ore on hand.

		Increase.	Decrease.
Quantity	Tons		
Estimated value	$		

16. Total estimated value of the mining product $

PRECIOUS METALS—REDUCTION WORKS AT MINES. *(Number printed, 25,000.)*

Special Schedule No. 11a.

Name of mine

Name of company, firm, or individual owner

General office

Location of mine: State County

Nearest city or town

Mining district or region

Name and address of superintendent

Bullion produced or contained in concentrates from ore or tailings treated in 1902:

	Fine ounces	Value
Gold		$
Silver		
	Pounds.	
Copper		
Lead		
Other metals (designate them)		
	Tons	
Total quantity of products other than bullion		
Total value		$

State general character and capacity of mill. [For instance, 20-stamp wet crushing, amalgamation with plates, 2 Frue vanners, and settling tanks. Capacity, 30 tons per 24 hours.]

Give any peculiarities in your process or mode of treatment.

Sources of material treated in 1902.

If any or all of the ore or other material treated by you in 1902 was custom material or was purchased from other parties, please give below the sources of such ores and the average assay or total bullion value of each.

State.	County.	Tons.	Value.	
			Gold.	Silver.

1. Bullion contents and gross value per ton of ore mined and milled:

Gold, fine ounces	
Silver, fine ounces	
Copper, per cent	
Lead, per cent	
Other metals, per cent	
Aggregate gross value	$

2. Bullion contents, total and per ton, and value of product from purchased materials.

	Product.			Average assay contents before treatment, per ton.
	Total quantity.	Per ton.	Total value.	
	Fine ounces.	*Fine ounces.*		*Fine ounces.*
Gold			$	
Silver				
	Pounds.	*Per cent.*		*Per cent.*
Lead				
Copper				
Other metals				
Total gross value			$	$
Average value per ton				

3. Bullion contents of the product of custom materials:

	PRODUCT.		
	Total quantity.	Per ton.	Total value.
	Fine ounces.	*Fine ounces.*	
Gold			$
Silver			
	Pounds.	*Per cent.*	
Lead			
Copper			
Other metals			
Total gross value			$
Average value per ton			

4. Average cost of smelting per ton of ore mined and milled:

Smelter charges	$
Freight	
Total	$

5. Total estimated value of the mining and milling product... $..........

6. Sources of material treated:

STATE.	County.	Tons.	TOTAL BULLION VALUE.	
			Gold.	Silver.
			$	$
Total domestic				
Total foreign				
Grand total			$	$

PRECIOUS METALS—PLACER AND SURFACE MINES. (*Number printed, 7,500.*)

Special Schedule No. 10b.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State ...., County ....

Nearest city or town ....

1. State character of deposit. [Whether stream sand, bench gravels, beach sands, ancient river beds, old tailings, etc.]
2. How is the deposit worked? [Whether by sluicing, drift mining, hydraulic mining, dredging, etc.]
3. Production:

	Ounces.	Value.
a. Gold, crude weight		$
b. Fineness of gold produced		
bb. Total fine ounces		
c. Average yield per ton or cubic yard of material handled		
d. State what accessory metals or gems are found, and the value of such in 1902		
e. State any values obtained from black sand or tailings		
Total value		$

REMARKS.

PRECIOUS METALS—LOCAL OR CUSTOM MILLS OR SMELTING WORKS.

(*Number printed, 2,000.*)

Special Schedule No. 11b.

Name of works ....

Name of company, firm, or individual owner ....

General office ....

Location of works: State .... County ....

Nearest city or town ....

Name of superintendent ....

Address ....

Production.

Total quantity of ore, tailings, or other material treated in 1902: (tons of 2,000 pounds) ....

	Ounces, fine.	Value.
Total yield in gold		$
Total yield in silver		
	Pounds.	**Value.**
Copper		$
Lead		
Other metals (designate them):		

Custom mills.

1. State general character and capacity of mill. [For instance, 20-stamp, wet crushing, amalgamation with plates, 2 Frue vanners, and settling tanks. Capacity, 30 tons per 24 hours.]
2. Give any peculiarities in your process or mode of treatment.

Local or custom smelting works.

1. State general character of process. [As "roasting in kilns," "smelting in stack furnace," etc.]
2. Give character and capacity of plant.

.........., *Superintendent.*

Sources of material treated.

In order that the producing districts may be properly credited, please furnish below an approximate statement of the sources from which your ores were obtained and the average assay or total bullion value. (Precious metals only.)

STATE.	County.	VALUE.	
		Gold.	Silver.
		$	$

A. Bullion contents, assay contents before treatment, and average value per ton of product from purchased materials.

	Contents of product.	Assay contents before treatment.
Gold, fine ounces		
Silver, fine ounces		
Lead, per cent		
Copper, per cent		
Other metals, per cent		
Average value per ton	$	$

B. Sources of material treated:

STATE.	County.	Tons.	TOTAL BULLION VALUE.	
			Gold.	Silver.
....	....	....	$........	$........
....	....	....	....	....
Total domestic		....	....	....
Total foreign		....	....	....
Grand total		....	$........	$........

NATURAL GAS. (*Number printed, 3,000.*)

Special Schedule No. 9.

Name of company, firm, or individual owner........

General office........

Number and group of wells reported on this schedule........

Location of wells: State........; County........

Nearest city or town........

Production.

1. Total value of gas produced and sold by you in 1902........ $........

[If possible, please give exact amount charged consumers. When this can not be done, as in the case where gas is consumed by those producing it, please estimate value by the amount of wood or coal necessary to do the same work.]

2. How much coal or wood would have been required to do the same work?

Tons........: Cords........

3. What would have been the value of this coal or wood? $........

4. Uses:

Number of domestic consumers supplied	....
Number of rolling mills supplied	....
Number of steel works supplied	....
Number of glass works supplied	....
Other establishments supplied	....
5. Number of wells producing gas December 31, 1901	....
Number of producing wells drilled in 1902	....
Number of wells abandoned in 1902	....
Number of wells producing gas December 31, 1902	....
Number of nonproducing holes drilled in 1902	....
6. Number of feet of gas pipe in use December 31, 1902	....

7. What cities or towns are supplied by you wholly or in part?........

REMARKS.

CRUDE PETROLEUM. (*Number printed, 5,000.*)

Special Schedule No. 9.

Name of group of wells........

Name of company, firm, or individual owner........

General office........

Location of wells: State........ County........

Nearest city or town........

Total amount of crude petroleum produced and sold by you in 1902 (bbls. of 42 gals.)........

Value of same at wells........ $........

Stocks at wells.

[Merchantable crude; bbls. of 42 gals.]

	Illuminating.	Lubricating.	Fuel.
December 31, 1901	....	....	....
December 31, 1902	....	....	....

Well records.

Total number of producing wells December 31, 1901	Ans........
Total number of producing wells drilled in 1902	Ans........
Total number of dry holes drilled in 1902	Ans........
Total number of wells abandoned in 1902	Ans........
Total number of producing wells December 31, 1902	Ans........

Production by months.

MONTH.	Crude, for illuminating.	Crude, for lubricating.	Fuel oil.	Total.
1902.	*Bbls. of 42 gals.*	*Bbls. of 42 gals.*	*Bbls. of 42 gals.*	*Bbls. of 42 gals.*
January	....	....	....	....
February	....	....	....	....
March	....	....	....	....
April	....	....	....	....
May	....	....	....	....
June	....	....	....	....
July	....	....	....	....
August	....	....	....	....
September	....	....	....	....
October	....	....	....	....
November	....	....	....	....
December	....	....	....	....
Total	....	....	....	....

REMARKS.

Please give any statement as to character, analysis, markets, etc., of your petroleum that may be of interest to the general public and that you are willing should be published, such as the well record. What is the character of the oil? Can you give analysis? What is its color? What is the character of strata in which it is found? What does it yield in illuminants? Etc.

IRON ORE. (*Number printed, 1,500.*)

Special Schedule No. 6.

Name of mine........

Name of company, firm, or individual owner........

General office........

Location of mine: State........ County........

Nearest city or town........

A. Underscore character of iron ore produced, and if more than one of the following classes is mined give quantity of each.

Limonite, brown hematite, or bog ore	....
Red hematite, specular or fossil ore	....
Magnetic ore	....
Carbonate or black band ore	....

B. State total quantity of marketable iron ore mined or produced during the year ending December 31, 1902.

........gross tons.
[If none, so state.]

Also stock of iron ore on hand at mine December 31, 1902.

........gross tons.
[If none, so state.]

C. Give total value on cars or carts at the mine of the iron ore produced during the year ending December 31, 1902.

$........

REMARKS.

MANGANESE ORE. (*Number printed, [illegible]*)

Special Schedule No. 6.

Name of mine........

Name of company, firm, or individual owner........

General office........

Location of mine: State........; County........

Nearest city or town........

A. State total quantity of marketable manganese ore mined or produced during the year ending December 31, 1902.

........gross tons.
[If none, so state.]

B. Also stock of manganese ore on hand at mine December 31, 1902.

........gross tons.
[If none, so state.]

C. Give total value on cars or carts at the mine of the manganese ore produced during the year ending December 31, 1902.

$........

REMARKS.

MINOR MINERALS. (*Number printed, 2,500.*)

Special Schedule No. 6.

Name of mine ....

Name of company, firm, or individual owner ....

General office ....

Location of mine: State .... County ....

Nearest city or town ....

Tons

Total quantity (approximately) of crude mineral ore produced in 1902 ....

[Please state whether long ton of 2,240 pounds or short ton of 2,000 pounds is used as the unit.]

If the product (or any part of it) is sold in the crude state, please say how much was sold crude in 1902 ....

Total value of same .... $

If the product (or any part of it) is subject to any process of concentration, reduction, or refining before being sold, please state briefly what the process is

Tons

How much of the product in 1902 was so treated? ....

Tons or pounds

Total quantity of concentrated or refined product obtained in 1902 ....

Total value of refined product .... $ ....

Any further information regarding the condition of trade and prospects of the future will be appreciated.

Please give the names of any new operators in your vicinity.

REMARKS.

Answers to the following inquiries on mines and quarries schedules do not appear in the detailed tables:

Schedule No. 6.

Inquiry 4.—Contract mining: Method of payment, by ton, car, yard, etc. Number employed. Amount paid.

Inquiry 5.—Time in operation: Number of hours in operation during the year. Number of hours per day. Number of shifts of workmen. Number of hours to shift.

Inquiry 9.—Product: Quantity of stone quarried. (Quantities were variously reported in perches, cords, tons, cubic yards, cubic feet, etc.)

Schedule No. 8.—Coal.

Inquiry 4.—(Same as in Schedule No. 6.)

Inquiry 5.—(Same as in Schedule No. 6.)

Inquiry 9.—Product: Number of mine cars of coal hoisted during the year. Average capacity of mine cars in pounds.

Inquiry 11.—Mechanical system of haulage, whether tail rope, endless rope, electric locomotive, compressed air, or other kind. (*Anthracite only.*)

Inquiry 12.—Are automatic slate pickers or coal cleaners used? (*Anthracite only.*)

Inquiry 13.—Number of washeries at colliery, and price per ton charged to washeries for culm.

Inquiry 14.—Nature of openings to works, whether shaft, slope, drift, or level, etc., and depth or length in feet of each.

Inquiry 15.—System of ventilation in use—fan, furnace, fire basket, exhaust steam, natural, or other kind.

Inquiry 16.—Rate per ton paid for coal mined on royalty.

Schedule No. 9.—Petroleum and natural gas.

Inquiry 10.—Tankage: Number of tanks at wells and their total capacity in barrels of 42 gallons.

Inquiry 11.—Wells: Number of wells drilled during the year. Number producing. Number of dry holes. Of total number of wells reported, state number flowing. Of total number of wells reported, state number pumping. Number abandoned during the year. What diminution of pressure occurred during the year?

APPENDIX B.

INSTRUCTIONS TO SPECIAL AGENTS.

MINES, QUARRIES, AND REDUCTION WORKS.

INSTRUCTIONS.

1. By an agreement between the Director of the United States Census and the Director of the United States Geological Survey, made to avoid a duplicate canvass of the mining and quarrying industry, and for other purposes, the Geological Survey will have supervision of the field work of the Census of Mines and Quarries. In accordance with this agreement, reports will be secured on both the Census Office schedules and the schedules of the Geological Survey for all mines, quarries, and reduction works in existence during the year 1902. The schedules for the two offices must be forwarded in the same envelope.

2. The agents will transmit all schedules promptly to the Geological Survey at Washington, D. C., unless specially instructed, as will sometimes be the case, to send them to the office of special agents of the Geological Survey in other places.

3. Agents are required to comply with all the regulations of the Census Office governing field work and to submit daily reports on the blanks prepared for that purpose. The names of establishments for which returns were secured, and also of those visited but for which reports were not obtained, must appear on the report for each day. The agents must, also, under "Remarks," state the character of the mineral for which they are securing reports and keep the office advised of the probable date on which they will complete their present assignment. Daily reports will be promptly transmitted to the Census Office through the Geological Survey and the relative efficiency of each agent determined therefrom.

4. Each agent will be furnished with a list giving the names, locations, and addresses of all mines, quarries, etc., assigned to him, which were in existence during the year ending December 31, 1902, together with a list of those for which returns have been obtained by correspondence. This list has been prepared from reports made to the United States Geological Survey in previous canvasses, amended by information received from other sources. The list, however, may not be entirely complete, and the agent, therefore, must be constantly on the alert to discover other mines or quarries. They must make careful inquiry at each city and town they visit for mines and quarries located in that vicinity. If such plants are discovered, and they are located in the territory assigned the agent, he should proceed to secure returns for them in the same manner that reports are secured from establishments on the lists. In forwarding the reports for unlisted mines or quarries, the agent must call attention to the fact that the establishments do not appear on the list furnished him.

5. The agent is required to visit the different localities in the order in which they are named on the list, unless he finds that railroad connections and local conditions make a change necessary. In such cases the condition and character of the change must be stated on the agent's daily report.

6. In all cases where an annual report of the establishment is printed, a copy of the latest report should be secured and forwarded with the schedule. Copies should also be returned of any other printed matter that will add to the information contained in the schedule.

7. In case a mine or quarry is owned by a company with an office in another locality, outside the territory of the agent, and it is impossible to secure a complete report at the plant, the agent must complete the schedule as far as possible from the data obtainable at the mine, and forward it to the Geological Survey with a full statement of the facts, giving also the names and addresses of the persons from whom further information may be obtained.

8. It is important that a separate return be made for each mine or quarry and that the statistics of employees, wages, expenses, and supplies entered on the schedule pertain only to the mine or quarry reported. This rule should be observed in all branches of mining and quarrying, except petroleum and natural-gas wells, where all the wells located in a certain group or district under one ownership should be reported upon the same schedule.

9. However, if more than one mine or quarry in the same county is owned by the same company or firm, and it is impracticable to make a separate report for each, a combined report may be made which will include the operations of all. Mines or quarries under the same ownership in different counties must be reported on separate schedules. If a schedule includes the operations of more than one mine or quarry, a memorandum giving the name and post office address of each mine or quarry included should be attached to the schedule.

10. All entries in the schedule must be made clearly and neatly in ink. Quantities and values must be obtained from book accounts, if such accounts are available. *Each question is to be answered.* If any question is found not applicable, and no amounts are reported, write the word "None."

11. An exact answer to each item enumerated in the several questions is what is required, and is what should be given if it can be secured with a reasonable amount of labor. In all cases where the answers are estimated the amounts must be preceded by the word "Estimate."

CENSUS SCHEDULES.

12. Reports must be secured for all mines and quarries and for reduction works engaged in reducing the ores containing the precious metals. The schedules on which these reports are to be made are seven in number, as follows:

13. Special Schedule No. 6. All mines and quarries must be reported on this schedule except those for which special schedules are provided. Mines and quarries of the following minerals are to be reported on this schedule: Bluestone, granite, limestone, marble, sandstone, slate, trap rock, grindstones, millstones, soapstone and talc, cement rock, clay, barytes, emery and corundum, gypsum,

mica, mineral paints, phosphate rock, iron ore, and manganese ore. Special attention is called to the fact that on this schedule also (Special Schedule No. 6) should be reported the nonargentiferous or soft-lead mines located east of the Rocky mountains, the copper mines of the Lake Superior region, and zinc mines. Other minerals, mined as such, to be reported on this schedule except where they accompany minerals of more importance, as platinum in gold placers, are the following: Antimony, asbestos, asphaltum, bauxite, borax, chrome ore, cobalt, feldspar, fibrous talc, flint, fluorspar, fuller's earth, garnet, graphite, infusorial earth and tripoli, magnesite, marls, molybdenum, monazite, oilstones, platinum, precious stones, pyrite, crystalline quartz, quicksilver, rutile, sulphur, tungsten, uranium, and vanadium.

14. Special Schedule No. 8, for Coal Mines, both anthracite and bituminous, and anthracite coal washeries.

15. Special Schedule No. 9, for Petroleum and Natural-Gas Wells.

16. Special Schedule No. 10, for Gold and Silver, and argentiferous and auriferous Lead and Copper Mines.

17. Special Schedule No. 11, for Reduction Works of the precious metals (other than Smelters and Refineries).

18. Special Schedule No. 6a, a supplemental schedule for administrative and general offices. This schedule is intended for corporations, firms, or individuals operating more than one mine, quarry, or reduction works, with a central office for all of them. Upon this schedule should be reported the employees of such central office with their salaries or wages, and all other employees whose work is not confined to one particular mine, quarry, or reduction works, such as general superintendents, machinists, surveyors, etc. All general expenses are also to be reported on this schedule and the data relating to capital stock, bonds, dividends, and assessments of incorporated companies. No data reported on this schedule should appear on the separate reports for the individual mines, quarries, or reduction works. Separate schedules are supplied for these individual plants.

19. Special Schedule No. 6b, a supplemental schedule for bluestone, granite, limestone, marble, sandstone, slate, and trap rock quarries, upon which a full description of the quarrying and stone-dressing machines in use should be given. This schedule is to be filled out in addition to and supplementary to Special Schedule No. 6 for all stone quarries.

Geological Survey Schedules.

20. There are, in addition to the schedules of the Census Office, schedules of the Geological Survey, and upon these are to be reported in detail the statistics of production of the various minerals, with other information as indicated on each. They are enumerated as follows:

Slate.
Marble.
Trap rock.
Granite.
Sandstone.
Bluestone.
Limestone.
Sulphuric acid.
Barytes.
Mineral paints.
Mica.
Salt.
Phosphate rock.
Gypsum.
Emery and corundum.
Millstones.
Grindstones.
Soapstone and talc.
Bituminous coal.
Anthracite coal.
Coke.
Coke, by product plants.
Brick and tile.
Pottery.
Clay mined.
Mineral waters.
Cement.
Deep mine (precious metals).
Reduction works at mines.
Placer and surface mines (precious metals).
Local or custom mills or smelting works (precious metals).
Natural gas.
Crude petroleum.
Iron ore.
Manganese ore.
Gas, tar, and ammonia.
Precious stones.
Minor minerals (a general schedule for the production of all other minerals not included in the foregoing list;

Industries Eliminated from Census Canvass.

21. Of the above minerals and subjects of inquiry by the Geological Survey it has been decided to eliminate from the Census inquiry the following: Brick and tile, coke, coke in by-product plants, gas, tar, and ammonia, mineral waters, pottery, salt, and sulphuric acid. Small placer gold mines at which less than two wage-earners are employed are also to be eliminated from the Census inquiry. Special agents are instructed not to obtain returns for these industries upon the Census schedule.

22. It is very essential that the Geological Survey and the Census Office schedules be transmitted together.

Mining and Manufacturing Industries.

23. There are several branches of mining in which the mineral products do not reach the market in the crude condition, but are subjected to certain processes at the mine or quarry before being regarded as marketable commodities. These may be processes of milling, separating, washing, burning, calcining, or other forms of manufacture. In some industries these processes are performed entirely at the mine or quarry, and in such cases the special agents are instructed that the census schedule should include the statistics of employees and wages, miscellaneous expenses, and supplies and materials involved in the entire work of mining the crude material and preparing the same for market. For example, the following branches of mining and quarrying are of this character: Emery and corundum mines, where finished emery wheels are frequently manufactured; mica mines, sheet and crushed mica being the finished product; graphite mines, where the crude graphite is refined; grindstone and millstone quarries, where grindstones and millstones are the finished products; mines or quarries of kaolin, flint, ocher, barytes, manganese, chalk, talc, mica, umber, sienna, and other iron-oxide colors, where the crude mineral is ground or otherwise prepared; marble, granite, and other stone quarries, where the stone is cut and dressed, and monuments and tombstones are manufactured; slate quarries, where roofing slate, slate blackboards, school slates, and sanitary plumbing slate slabs are manufactured. In all such cases as the foregoing and others where any form of manufacturing is necessary at the mine or quarry before the product is placed on the market the census schedule should cover the entire work of the establishment.

Instructions for Filling out Schedules.

24. The Census Office schedules must be carefully prepared in conformity with the general practice of the division of manufactures in gathering statistics concerning manufactures, street railways, electric light, etc. The agents who have been detailed from the Census Office are familiar with these methods. All questions must be carefully answered, and amounts reported in answer to each inquiry should be tested individually and with the totals. The following general instructions for filling out Special Schedule No. 6 will apply to the similar general features and inquiries of each of the several census schedules.

25. Give on the first page of the schedule the name of the mine or quarry; the character of the mineral; the name of the company, firm, or individual owner; the location of the mine or quarry (state, county, nearest city or town, and post office); and the address of the general office, if different from that of the mine or quarry. Obtain, also, the signature and official designation of the person furnishing the information. The signature of the special agent should be written on each schedule returned.

Inquiry 1.—Character of Organization.

26. Under this inquiry should be reported the character of the organization under which the mine or quarry is owned and operated.

Inquiry 2.—Capital Stock, Bonds, Dividends, and Assessments of Incorporated Companies.

27. This question does not apply to any other forms of mining and quarrying organizations than incorporated companies. Account

for the entire amount of common and preferred stock and bonds, respectively, authorized, the amount of each issued up to the end of the year for which the report was made, giving the number of each class, the par value, and the full amount of dividends paid during the year on each class of stock and on bonds. The total amount of assessments levied by organizations known as "assessment companies," whether incorporated or unincorporated, should also be reported.

INQUIRY 3.—EMPLOYEES, SALARIES, WAGES, ETC.

28. Account for all persons employed at the mine or quarry, both in the management and in the operation of the plant. Give the number of officers who receive salaries (not the number of stockholders), and the gross amount of their salaries. Report separately the number and wages of each class of employees specified. The salaries and wages should include board or rent furnished as part compensation.

29. The wages reported for miners or quarrymen and stonecutters should be their net wages, and should not include the cost of supplies furnished by the company and charged to them, such as explosives, lamp oil, etc., and blacksmithing charges.

30. Care should be taken that those employed "above ground" and those "below ground" be reported separately.

31. Amounts paid for contract work not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but be reported in answer to Inquiry 6.

32. The average number employed during the year is the number that would be required at continuous employment for the twelve months to produce the quantity of product reported. There should be no difficulty in securing this information for the plant of ordinary size, but it may be that the large companies keep an itemized pay roll, the total only being carried forward from each week or month. In such cases it will be necessary to add on a separate sheet the pay roll of each week or month for each class of employees.

33. *Average number of wage-earners at specified daily rates of pay.*—This inquiry is designed to ascertain the average number of employees for each of the eight classes enumerated that receive the daily rates of pay specified.

34. *Average number of wage-earners employed during each month.*—The object of this inquiry is to obtain the average number of wage-earners employed during each month as distinguished from the average number employed during the entire year. If properly answered, it shows the variation in the number employed at different seasons of the year.

INQUIRY 4.—METHOD OF PAYMENT FOR MINING OR QUARRYING.

35. This inquiry is intended to elicit information regarding the manner in which payment is made for mining or quarrying when not done by the day. It has an important bearing upon labor and wages in certain branches of the mining industry, particularly in coal mining, and should be very carefully answered. The manner of payment for the class of work referred to is sometimes different at the same mine. This should be reported if not done by the day, with the average number of men engaged and the total amount paid for such work, also any allowances that may be made in addition to the regular schedule of wages for difficult mining or other considerations.

INQUIRY 5.—TIME IN OPERATION.

36. The object of this inquiry is to ascertain the time that the mine or quarry was in operation during the year.

INQUIRY 6.—CONTRACT WORK.

37. Extensive improvements or development work, such as tunneling, shaft sinking, boring test holes, etc., are frequently let out by contract, and are not done by regular employees of the mine or quarry. The amount paid for such work, the average number of men engaged and the number of days employed, should be reported. Although the book accounts of such work, except the amount paid for it, are not kept by the mine operator, it is thought that a correct estimate of the average number of men engaged and the number of days employed can be furnished.

INQUIRY 7.—SUPPLIES AND MATERIALS.

38. The actual cost of all supplies and materials used during the year, including freight paid on the same, must be reported. The cost of the following materials should be reported under this inquiry: Lumber and timber used for repairs, mine supports, track ties, cars, and for all other purposes; iron and steel for blacksmithing, rails, frogs, sleepers, etc., for tracks and repairs, parts of machinery and tools used for renewals and repairs; explosives, water for boilers and for other purposes, fuel, illuminating and lubricating oils, machinery supplies, etc.

39. It is frequently the case when the crude mineral is put through a process of milling, refining, calcining, or other manufacturing at the mine or quarry, as at gypsum, limestone, and cement quarries, that crude material is purchased from other mines or quarries that are not equipped for such work. The quantity and cost of material so purchased should be separately reported under this inquiry.

INQUIRY 8.—MISCELLANEOUS EXPENSES.

40. All items of expense incident to the operation of the mine or quarry, not accounted for under Inquiries 3, 4, 6, and 7, must be reported under this inquiry. Care should be taken that royalties paid for mineral taken out from leased land and other forms of rent for the mine or quarry be reported separately under the first item of this inquiry. Under the second item should be reported all other miscellaneous expenses, such as taxes on real and personal property, insurance on buildings, interest on borrowed money, etc. Do not include any portion of the freight reported under Inquiry 7 as paid on supplies and materials.

INQUIRY 9.—PRODUCT.

41. As stated in a preceding paragraph, the statistics of production will be reported in detail on the schedules of the Geological Survey, and only the total quantity and total value will be reported on the Census schedule. The figures on both schedules must agree. The value reported should be the spot value f. o. b. at mine or quarry, except in the returns of natural gas wells, where the price to the consumer should be given, as obtained from the books of the company.

INQUIRY 10.—POWER.

42. Under this inquiry should be reported all mechanical power employed, either owned or rented, including the number and horsepower of all engines, motors, water wheels, etc., used for ventilating, pumping, hoisting, derricks, surface machinery, and all other purposes.

43. Care should be taken to report correctly "Power owned" and "Power rented." When an entire plant, including engine or water wheel, is rented, the power thus controlled is to be regarded as "Power owned" and entered under 10a. "Power supplied by other establishments" (10c) should include only cases where the mechanism generating the power is in the control of another party.

44. The foregoing instructions will apply to all inquiries in the Census schedules, except several special and additional inquiries peculiar to certain branches of the mining industry.

Instructions for answering those special inquiries are given in the following:

SPECIAL SCHEDULE NO. 8.—COAL MINES.

45. In addition to the detailed information relating to the product of coal mines provided for in the schedules of the Geological Survey, under Inquiry 9, on the Census schedule the number of cars of run of mine coal taken from the mine during the year, and the average capacity of the mine cars, in pounds, should be reported. This information is easily accessible, and can be given in all cases with little trouble by the foreman at the colliery.

46. The information called for in Inquiries 11, 12, 13, 14, and 15 relates to the equipment of the mine and can be readily given by the foreman. It is important that complete information be given in reply to these inquiries. The rate of royalty per ton should be given under Inquiry 16, if paid on all or part of the output of the mine during the year. The total amount so paid should be reported under Inquiry 8.

SPECIAL SCHEDULE NO. 9.—PETROLEUM AND NATURAL-GAS WELLS.

47. It is important that complete statistical information regarding the storage capacity for crude petroleum at the wells and the development and exploration work done during the year and the results of that work, as evidenced by the number and condition of wells drilled during the year, be reported in reply to Inquiries 10 and 11. Describe fully, also, the diminution of pressure, if any, that has occurred during the year.

SPECIAL SCHEDULE NO. 10.—GOLD, SILVER, LEAD, AND COPPER MINES.

INQUIRY 2.

48. This inquiry should be answered in all cases when the working of a mine was discontinued for a number of years and subsequently resumed.

INQUIRY 9.—MISCELLANEOUS EXPENSES.

49. The four items of rent specified under this inquiry should be reported separately in case the owner of the mine and mineral lands, the party who erected the mining plant and developed the mine, and the operator are different persons, and the lessee is required to make separate payments to the patentee, to the development company, to the tunneling company, etc.

50. The answers should in all cases be obtained from the mine operator, but the addresses of the owner and lessor from whom the operator holds his lease should be obtained for reference, likewise the address of the tunneling company.

51. In case the mine is worked by the hydraulic method, the address of the owner of the water plant should also be obtained for reference.

52. If, in addition to the four items of rent, offices or any other facilities are rented, specify each kind and state the total amount paid in the column reserved for the same.

53. If two or more items of rent are paid in one sum to the same party, give the amount paid and state for what it is paid.

INQUIRY 10.—PRODUCT.

Gross value of metallic contents, as reported to the United States Geological Survey.

Deductions: Charges for treatment and freight, per ton and total.

Net value of mining product.

54. The gross value of the metallic contents of the product is to be transferred to this schedule from the schedules of the United States Geological Survey. In order properly to answer this inquiry, it must therefore be read in conjunction with the schedules of the Geological Survey; there is one schedule relating to "Deep mines" and another relating to "Placer and surface mines."

55. *Deep mines.*—The product of deep mines is ore. Ore is either sold, treated at a mill connected with the mine, or treated at a custom mill.

56. The customary method of settlement for ore purchased by samplers, smelters, etc., is the following: The ores are sampled and the contents of each metal are determined by assay. All the gold contained in the ore is paid for at a stated rate, usually very near the rate paid by the United States mints or assay offices for unrefined bullion—that is, about $20 per ounce fine. The silver contents are paid for at the current New York price per ounce fine, with a discount of a few per cent for losses in smelting, etc. Base metals contained in the ore are paid for at a stated price per unit (per pound, or percentage contained in the ore).

57. From the gross value of the metallic contents thus computed deduction is made for working costs and freight at a stated rate per ton of ore. The balance, after making these deductions, is the net value of the ore f. o. b. at mine, for which payment is made by the purchaser.

58. The Geological Survey schedule for "Deep mines" contains the following inquiry:

"4. Total bullion contents of above ore sold or treated in 1902."

59. If the ore was sold, the special agent, after entering on the Geological Survey schedule for "Deep mines" the quantities and *gross* values of the precious and base metals contained in the ore, will transfer the "Total value" from that schedule to Special Schedule No. 10, entering it in the blank space against "Gross value of metallic contents, as reported to the United States Geological Survey."

60. Next enter under "Deductions" the charges for treatment, per ton and total, and freight, per ton and total. Unless the rates per ton underwent a change during the year 1902, the total must be equal to the rate per ton multiplied by the total amount of ore sold in 1902, reported in answer to Inquiry 2 on the schedule of the Geological Survey.

61. The "Net value of mining product" is equal to the total amount realized by the mining company for all ores sold during the year 1902. The amount should be furnished by the manager of the mine. It must be equal to the gross value reported to the Geological Survey less charges for treatment and freight reported under this inquiry. If the balance does not agree with the answer, the discrepancy will indicate that some of the answers are incomplete or incorrect. The mistake should be corrected before leaving the establishment.

62. If the ore is treated at a mill operated under the same management, a report similar to the foregoing should be made whenever separate accounts are kept for the mine and the mill. If this is not possible this inquiry need not be answered, and an answer will be given, covering both the mine and the mill, on Special Schedule No. 11, under Inquiry 9.

63. If the ore is treated at a custom mill and the bullion, concentrates, or other product, after being returned to the mine operator, are sold to a smelter, the total charges for treatment should be reported, including both the cost of milling and the smelting charges; the freight should in such case likewise include both the cost of carriage to the custom mill and the freight charges made by the smelter.

64. *Placer and surface mines.*—Most of the placer gold finds its way into the United States mints and assay offices, and is paid for according to weight and fineness at the legal rate, a small charge being made for refining. The crude gold or dust which goes to private smelters and refineries is paid for at a fixed rate per crude ounce for every producing district. Accordingly, if the gold dust is deposited at a United States mint or assay office, the value on the schedule of the United States Geological Survey should be given at the full legal rate of $20.67 per ounce fine, and the mint charges should be entered on Special Schedule No. 10, under "Deductions, charges for treatment."

65. If any values are obtained from tailings, the same should be added to the value of the gold product, and the total should be transferred to Special Schedule No. 10.

66. If the gold dust is sold to a private smelter, the value given will be that fixed per ounce crude, as explained above; the special agent, after transferring the same from the schedule of the Geological Survey to this schedule, should write in the blank spaces under "Deductions" the word "None"; the gross value of metallic contents transferred from the schedule of the Geological Survey should be repeated in the blank space reserved for "Net value of mining product."

Inquiry 11.—Name and Address of Mill or Works at Which the Ore is Treated.

67. If the mill at which the ore is treated is operated by the same mining company, state the fact in answer to this inquiry.

68. If the ore is treated at a custom mill, state "Treated at a custom mill," and give the name and address of the same.

69. If the ore is sold, state "Sold to (giving name and address of buyer)."

70. If it is deposited at a United States mint or assay office, state at which.

71. *By what method is the ore conveyed from the mine to the mill?*

The method should be described only when the mill is located in the vicinity of the mine, for example: By wagon, by tram, by steam or electric railroad connecting the mine with the mill, etc. If the ore is shipped by freight or express, state the fact.

Inquiry 12.—Mineral Lands.

72. This inquiry is intended only for "Mineral lands" which are held under a patent from the United States Land Office, or under a location certificate, and not for any other real estate.

Inquiry 13.—Water Plant.

73. This inquiry relates only to hydraulic mines, or such as were formerly worked by the hydraulic method and have since turned their water plant into a source of motive power.

Inquiry 14.—Length of Railroad Tracks Owned.

74. All tracks should be reported; those owned by the mining company itself, or by a railroad company whose stock is held by the mining company. State separately the length of tracks on the surface and underground. If no tracks are owned, answer "None."

Inquiry 16.—Machinery.

75. State number of machines of each class and kind of power by which they are operated. Do not give horsepower, which must be reported under Inquiry 15.

SPECIAL SCHEDULE NO. 11.—REDUCTION WORKS (OTHER THAN SMELTERS).

76. A separate report must be made on this schedule for every reduction works, whether operated independently or jointly with a mine. In case, however, no separate accounts are kept for the mine and the works, a full report covering both should be made on Special Schedule No. 10, leaving Inquiry 10 on that schedule unanswered, and answers should also be given to Inquiries 4, 5, 9, 10, and 12 on this schedule.

Inquiry 5.

77. This inquiry should be answered only where the product of the reduction works is shipped for further treatment to some other custom mill (for example, where concentrates are treated at a cyaniding mill), or where the product of the mill is treated at a custom smelter.

Inquiry 6.—Materials.

78. *State character of materials used, whether ore, tailings, or other materials.*—The answer should enumerate all materials, those coming from the company's own mines as well as those bought or treated for customers.

79. *Total assay contents and value of all materials bought in 1902.*—The answer to this inquiry should be confined to such materials only as were bought from other persons.

The method of settlement for purchased ores is fully described in the instructions to Special Schedule No. 10, Inquiry 10, to which reference is here made.

Inquiry 9.—Product.

80. *Gross value of metallic contents as reported to the Geological Survey.*—The answer to this inquiry must be transferred from the schedule of the Geological Survey relating to "Reduction works at mines," or from that relating to "Local or custom mills or smelting works," as the case may be. It should be remembered, however, that Special Schedule No. 11 applies only to "Reduction works other than smelters." Special schedules relating to smelters will be placed in the hands of special agents in particular cases only.

81. In order that the information wanted by this office be properly transferred from the schedules of the Geological Survey, the following instructions should be carefully noted. The method of settlement for concentrates, amalgam, cyanides, crude bullion, etc., is similar to that described in the instructions to Special Schedule No. 10, Inquiry 10, to which reference is made.

82. *Reduction works at mines.*—In this case the product will be reported on the following four schedules: (1) Schedule of the Geological Survey relating to "Deep mines." (2) Schedule of the Geological Survey relating to "Reduction works at mines." (3) Census Schedule No. 10. (4) Census Schedule No. 11.

83. If, in addition to the ores mined and milled by the same company a part of the product of the reduction works is from purchased ores, then the bullion contents, reported on the first of the above-enumerated schedules, will give only the product of the company's own mines, and the bullion contents reported on the second schedule the whole product of the reduction works. The former should be transferred to Special Schedule No. 10, and the latter to Special Schedule No. 11.

84. *Custom material.*—What has been said in reference to purchased ores likewise applies in the event, in addition to the ores mined by the same company, custom ores were treated by the reduction works. In many cases, however, the management of the reduction works has no information as to the metallic contents of custom ores treated, beyond their tonnage. Whenever custom ores were among the materials treated at the reduction works, the special agent should ascertain whether the bullion contents of the same are or are not included in the amounts and values given in the schedule for "Reduction works at mines;" and in transferring the value to Special Schedule No. 11, Inquiry 9, he should write immediately after "Product" the following words: "including product of custom ores," or "not including product of custom ores," as the case may be.

85. *Geological Survey schedule relating to "local or custom mills or smelting works."*—As stated above, reports from smelters are not to be transferred to Special Schedule No. 11. The instructions given above in relation to "Custom materials" likewise apply to mills not connected with mines.

Inquiry 10.—Custom Work Done by this Establishment.

86. Report separately the quantity treated of (1) ore, (2) concentrates or other material previously treated at other reduction works, (3) tailings; state the total amount received for the treatment of each, exclusive of freight, and the total freight paid on each.

INQUIRY 12.

87. Give the addresses and character of establishments to which the products were sold or shipped for treatment, for example: Gold, to the United States mint at (location); silver, to the smelter of (name) at (location); concentrates from tailings, to cyaniding plant of (name) at (location), etc.

SPECIAL SCHEDULE NO. 6a, ADMINISTRATIVE AND GENERAL OFFICES.

88. As previously explained, this schedule is intended for the general office reports of establishments operating more than one plant. In such cases great care should be taken that no data included in this schedule be included in any of the reports for the individual mines or quarries, and all data chargeable to a particular mine or quarry should be included in the report of that plant and not in the administrative or general office report.

SPECIAL SCHEDULE NO. 6b, STONE QUARRIES.

89. This schedule is supplemental to Special Schedule No. 6, for the reports of stone quarries, and should in all cases be returned with the complete report of stone quarries. It should contain a full description, as provided on the blank, of all quarrying and stone-dressing machines in use. If such machines are not used, Special Schedule No. 6b should be returned containing a statement to that effect.

90. In order to insure the success of the cooperation between the Geological Survey and the Census Office, in taking the census of mines and quarries, there must be perfect agreement between the published reports of the two bureaus. To secure this, and to minimize the work of correspondence, correction, and revision, the utmost pains should be taken to obtain, for all branches of the investigation, correct returns in which the answers to the various inquiries will conform to each other and harmonize throughout. Careful study should be given to all instructions relating to the work of the special agents.

APPENDIX C.

INSTRUCTIONS FOR EDITING AND REVISING THE SCHEDULES.

GENERAL INSTRUCTIONS.

All corrections or additions to schedules should be made neatly and plainly in red ink.

No change or correction of importance should be made except on the advice of the clerk in charge.

Whenever cents are reported on a schedule, if 50 cents or over, a dollar should be added to the amount and the cents striken out; if less than 50 cents, they should be stricken off the schedule.

The Instructions to Special Agents giving directions for filling out the schedules should be carefully studied in so far as they affect the census schedules. As shown therein each mineral should be reported upon a specified schedule. This question should receive primary consideration. The instructions relating to the various industries to be reported on the several schedules are as follows:

Reports should be secured for all mines and quarries and for reduction works engaged in reducing and concentrating the ores of the precious metals. The schedules on which these reports are to be made are seven in number: Special Schedule No. 6, for mines and quarries in general, for which no other special schedule is provided. Mines and quarries of the following minerals are to be reported on this schedule: Slate, marble, trap rock, granite, sandstone, bluestone, limestone, barytes, mineral paints, mica, phosphate rock, gypsum, emery and corundum, millstones, grindstones, soapstone and talc, clay, cement rock, iron ore, manganese ore. Special attention is called to the fact that on this schedule, also (Special Schedule No. 6), should be reported the nonargentiferous or soft-lead mines located east of the Rocky mountains, the copper mines of the Lake Superior region, and zinc mines. Other minerals, mined as such, to be reported on this schedule, except where they accompany minerals of more importance, as platinum in gold placers, are the following: Antimony, asbestos, asphaltum, borax, bauxite, chrome ore, cobalt, feldspar, fibrous talc, flint, fluorspar, fuller's earth, garnet, graphite, infusorial earth and tripoli, magnesite, marls, molybdenum, monazite, oilstones, platinum, precious stones, pyrite, crystalline quartz, quicksilver, rutile, sulphur, tungsten, uranium, and vanadium. Special Schedule No. 8, for coal mines, both anthracite and bituminous, and anthracite coal washeries. Special Schedule No. 9, for petroleum and natural-gas wells. Special Schedule No. 10, for gold and silver, and argentiferous and auriferous lead and copper mines. Special Schedule No. 11, for reduction works of the precious metals (other than smelters and refineries). Special Schedule No. 6a, a supplemental schedule for administrative and general offices. This schedule is intended for corporations, firms, or individuals operating more than one mine, quarry, or reduction works, with a central office for all of them. Upon this schedule should be reported the employees of such central offices, with their salaries or wages, and all other employees whose work is not confined to one particular mine, quarry, or reduction works, such as general superintendents, machinists, surveyors, etc. All general expenses are also to be reported on this schedule and the data relating to capital stock, bonds, dividends, and assessments of incorporated companies. No data reported on this schedule should appear on separate reports for the individual mines, quarries, or reduction works. Separate schedules are supplied for these individual plants. Special Schedule No. 6b, a supplemental schedule for sandstone, granite, marble, trap rock, bluestone, limestone, and slate quarries, upon which a full description of the quarrying and stone-dressing machines in use should be given. This schedule is to be filled out in addition to and supplementary to Special Schedule No. 6 for all stone quarries.

CLASSIFICATION.

The schedules may be separated into three main groups—those representing establishments that were active and engaged in production during 1902, idle or nonproductive establishments, and schedules that in no manner represent active or idle mines or quarries but are from men who have retired permanently from business, from mines or quarries that have been worked out or abandoned, or from establishments that may be eliminated from the Census of Mines and Quarries, or for other reasons. Reports from mines or quarries that were in process of development—no production being reported during 1902—should be classified as "Idle" unless there are special reasons for omitting them presented in the information accompanying the schedule. These three classes of schedules should be filed separately and the two latter should be stamped "Idle" or "Omit," respectively, on the right of the center of the top margin of the schedule.

Each schedule should be classified with the name of the mineral of chief importance produced, as reported on the production card of the Geological Survey, the classification to be written in red ink on the upper left-hand margin of the schedule. The number placed on the upper left-hand corner of the schedule, which corresponds to the number on the schedule of the Geological Survey, should not be obliterated or in any manner obscured in writing the classification.

It sometimes occurs that two classes of mineral, or two products which require different classifications, are produced in the same quarry, and only one report has been made covering the entire operations. In such cases it is frequently impossible to make any separation of the data reported under the several inquiries so as to present a separate report for each branch of the business. Instances of this kind are when limestone quarrying and cement manufacturing are done at a quarry and a part of the product of the quarry is sold in its crude state for building and other purposes, or when grindstones are made at a sandstone quarry and a certain proportion of the quarried stone is sold for building and other purposes, this condition in both of these instances necessitating two reports of the product to the Geological Survey.

It is impossible or impracticable in such cases to make a report for each branch of the business, therefore the combined report will be accepted and should receive the classification of the predominating products as shown by the production slips. A Census schedule should be made out for the less important product, containing only such information as is necessary for filing purposes, such as the classification, name, and location, but no statistical data except the product. This schedule should be made out in red ink. Cross references should be made in each schedule and Survey slip, one to the other. In the Census schedule which contains the complete report the cross reference should be about as follows: "See also Cement No. 86, Jones and Smith, Pageville, Ohio, for additional cement product." On the blank Census schedule for the less important product the cross reference should be in about the following terms: "See also Limestone No. 72, Jones and Smith, Pageville, Ohio, for all data other than cement product." Corresponding references should be written on the Survey slips.

The following instructions are intended to apply to Special Schedule No 6 and to the similar general features and inquiries of the other Census schedules:

The classification should be verified by comparing with the copy of the Geological Survey schedule which accompanies each Census schedule. The schedule should receive close examination to ascertain if it includes more than one mine or quarry, and if so, that fact should be clearly stated in red ink in the space below the classification at the top of the schedule on the left-hand side as follows: 3 mines or 5 quarries, as the case may be.

Title page.—The information called for on the first page of the schedule should be reported in full, each item of information being written plainly in the space provided.

Inquiry 1—Character of organization.—It is probable that the character of the organization under which mines and quarries are operated will be in all cases one of the five classes specified. This information should appear on all schedules.

Inquiry 2—Capital stock, etc.—If the character of organization as reported under Inquiry 1 is that of an "incorporated company," the necessary information relating to the same should appear under this inquiry. The number of shares of each kind of stock and the number of bonds, with the total par value of the same, should be reported. The total par value should be that of the entire amount of bonds or stock, and not that of a single share. It is not necessary that all incorporated companies report bonds and both classes of stock. Bonds and preferred stock will very frequently not appear, as this class of liabilities in the cases of many corporations is solely common stock.

The amount reported as issued should not be in excess of the amount reported as authorized, and the number of shares of stock and the number of bonds should not be inconsistent with the par value.

The "authorized" and "issued" stock should be reported in all instances.

The amount of dividends, if any, paid during the year on common and preferred stock should be the result obtained by multiplying the par value of common and preferred stock issued to the end of the year by the "rate" reported. If the amount is reported and no rate, the rate should be calculated and supplied, and vice versa.

A report showing bonds should show the rate of interest on the same, although no interest is reported as paid.

In cases where an incorporated company owns more than one mine or quarry and a Special Schedule No. 6a has or has not been filled out, it frequently occurs that the details of capital stock and the general officers are included in each of the individual schedules, thus duplicating and triplicating, etc., this information. In all cases of this kind, after being assured that an apportionment of the capital stock, etc., has not been made among the individual schedules, the duplicated data should be stricken off all schedules except one and a note substituted to the effect that the information is reported on Schedule —— (giving the name of the mine and location).

Inquiry 3—Persons employed.—The information reported under this inquiry should be very carefully examined, and the three sections of the inquiry should agree with each other and with other inquiries that have the least bearing upon the question of employees and wages.

The numbers of the several classes of employees reported should not be out of proportion with each other, nor with the character and extent of the mine or quarry reported on the schedule. No employees should be reported "below ground" for quarries or surface mines.

The average number of "wage-earners," which includes all classes of employees other than general officers, superintendents, managers, etc., and clerks reported in the first section of the inquiry, should agree in number with those reported under "Wage-earners at specified daily rates." The total average number of wage-earners under these two sections of the inquiry should accordingly be written in the margin of the schedule. The total wages reported for all employees after clerks, except foremen "below ground" is the amount of wages to be used in comparison with the second section of the inquiry. This amount should be written in red ink in the margin of the schedule. The wages that would be earned by the employees reported at specified daily rates, at the rates given, the mean rate being used in the calculation, and for the time in operation as reported under Inquiry 5, should agree approximately with the amount reported under the first section of the inquiry. This comparison should be made for the entire number of wage-earners and for each corresponding class of wage-earners. To obtain the average number of wage-earners during the year, reported under "Average number of wage-earners employed during each month," add the numbers reported for each month and divide the total by 12, the number of months in the year. This calculation should be made on the left-hand margin of the schedule in red ink.

The average number employed during the year, under the first and second sections of Inquiry 3, must be the number that would be required to produce the quantity of product reported, working continuously for twelve months. Therefore, if a mine or quarry had suspended operations for any protracted length of time during the year, the average number of wage-earners, under the first and second sections of Inquiry 3, must be reduced by that proportion of the number reported that the period of idleness is to twelve months, providing the average number as reported in answer to these sections is approximately the same as the average number employed during each month the mine or quarry was in operation. When necessary to make such reduction, the amounts paid in wages to the several classes of employees must be approximately the amounts they would receive if employed the full number of working days in the year at the specified daily rates of pay, and not the amounts they would receive for the actual number of days employed at the rates reported. The reduction of the average number of employees that may be necessary should not always be applied to "Superintendents, managers, etc.," "Clerks," and "Engineers, firemen, etc.," as these employees generally work full time whether the mine is idle or in operation. However, if the computation shows that they were employed only while the mine was operated, the reduction should be applied to them the same as to the other employees.

There should be a substantial agreement in the rates of wages shown on the different schedules from establishments engaged in the same branch of industry in the same locality.

Inquiry 4.—The information reported under this inquiry should be reported also under Inquiry 3. The number of employees and amount paid should be included in Inquiry 3, under "Miners or quarrymen and stonecutters" for surface mines or quarries, and under "Miners" and "Miners' helpers" for underground mining. The inquiry is intended to develop the manner of payment for the actual work of mining or quarrying when not done by the day. As there is not frequently a diversity in the method of payment for identical work in the same mine or quarry, it is thought that the data reported as to the average number of employees and total amount paid in this inquiry will, in most cases, be the same as that reported under the heads provided for this information in Inquiry 3.

Inquiry 5—Time in operation.—The information reported under this inquiry should be considered in connection with the answers to Inquiries 3 and 9, and in verifying the amount reported as paid in wages by the specified daily rates and the number of wage-earners reported at each, the number of days in operation, and the number of shifts of workmen reported under this inquiry should be taken into account. The number of shifts of workmen reported will be one in the large majority of cases, and sometimes two or three. A larger number of shifts is open to question. In quarrying and surface mining if more than one shift is reported it is questionable. This is also true of certain other branches of mining. The number of hours to a shift will in most cases be 10, frequently 8, and sometimes 12.

Inquiry 6—Contract work.—The information reported under this inquiry is entirely separate from any data given under Inquiry 3 and should not be included therein. It is frequently the custom to let such work as tunneling, shaft sinking, boring, etc., out by contract, and no record is kept by the officers of the mine or quarry of the wage-earners employed and the wages paid, and as it is in most cases impossible to obtain the information from the contractor, it will be estimated and given by the mine or quarry operator. Contract miners or quarrymen who work by the ton, car, yard, etc., should not be reported under this inquiry but under Inquiries 3 and 4.

Inquiry 7—Supplies and materials.—The character of the expenditures to be reported under this inquiry is shown on the schedule. It should always be considered in connection and compared with the product reported and answers to other inquiries. Except under extraordinary circumstances, the amount reported will not be in proportion to the value of the product. It will frequently be found to be the case that no amount is reported under this head, particularly in very small mines or quarries, and in such cases it should be accepted as correct.

It is frequently the case when the crude mineral is put through a process of milling, refining, calcining, or other manufacturing at the mine or quarry, as gypsum, limestone, and cement quarries, that crude material is purchased from other mines or quarries that are not equipped for such work. The quantity and cost of material so purchased should be separately reported under this inquiry.

Inquiry 8—Miscellaneous expenses.—All items of expense incident to the operation of the mine or quarry, not accounted for under Inquiries 3, 4, 6, and 7 must be reported under this inquiry. Care should be taken that the royalties for mineral taken out from leased land and other forms of rent for the mine or quarry be reported separately under the first item of this inquiry. It will be frequently found to be the case that no amount is reported under this head, particularly in very small mines or quarries, and in such cases it should be accepted as correct.

Inquiry 9—Product.—Inclosed with each schedule will be found a copy of the card of the Geological Survey containing a detailed report of the product. The product as reported on this card, and not as entered on the schedule, will be tabulated and included in the published reports. It will, therefore, be taken as the product in editing the schedules when considering its relation to the data reported in reply to the other inquiries.

This question should receive very careful examination and be carefully compared with the replies to other inquiries. The quantity reported should be consistent with the number of employees and the time in operation; the kind of mineral, and the conditions of mining it should also be considered in this connection. The value per unit of the product should be examined to see that there is not a very great difference between the average value shown in the schedule and the average ruling price of the article under consideration during 1902.

As it is necessary that the quantity and value of the product published in the reports of the Census Office and in those of the Geological Survey agree, under no circumstances should any change be made in this information without the permission of the section chief.

Inquiry 10—Power.—The first consideration in examining this question is as to whether or not the use of mechanical power is required. This question is determined by the size of the mine or quarry, and by the character or method of mining. In a very large number of quarries and open mines generally, no power is used, but if they are of considerable magnitude some equipment for power purposes is necessary. In a large majority of cases the power reported will be steampower.

Before closing any branch of the mineral industry, and tabulating the schedules, the files should be searched and all No. 6a schedules withdrawn. The information reported under Inquiry 6 should then be carefully checked against the individual mine and quarry schedules to see that all the schedules are on file.

If the mines or quarries are all located in the same county, the data reported on the No. 6a schedule should be added to any one of the individual schedules and an examination made of the others, for the purpose of eliminating this data, if duplicated on such schedules. Care should be taken that all information under Inquiries 1 and 2 be stricken off all schedules, except one, and a suitable cross reference made to the schedule containing the information. If the mines or quarries are located in different states or counties, or if there is more than one branch of mining, the data on the No. 6a schedule should be apportioned among the different states and counties, or branches of mining, as the case may be, the apportionment being based on the value of the product.

INSTRUCTIONS FOR EDITING SPECIAL SCHEDULES.

The foregoing instructions are intended for general application in editing the returns of mines and quarries of all kinds. In addition, there are certain special schedules which contain peculiar features and require further explanation.

SPECIAL SCHEDULE No. 8—COAL MINES.

Inquiry 3—Persons employed.—Care should be taken that the employees are correctly reported "above ground" and "below ground." Only an insignificant proportion of coal mines are surface mines, and in such cases the mines should be reported under. Inquiry 14 as "Open cutting or stripping." Roughly stated, in bituminous coal mining, about nine-tenths of the entire force of employees work underground, but in anthracite mining, on account of the large plants on the surface for screening and cleaning the coal, the proportion underground is less than in soft coal mines, being about two-thirds.

The timbermen and track layers separately stated under the second section of this inquiry should be included among "All other employees" below ground, in the first section of the inquiry.

Inquiry 4—Average number of employees and rates paid.—As the actual work of coal mining is seldom done by the day, the number of miners and miners' helpers, with their earnings, should be reported here. This information should also be reported under the first section of Inquiry 3. Under the second section of Inquiry 3, where miners are paid by the ton, car, or yard, the specified daily rate under which those contract miners are reported should be the same for the entire number of this class of workmen. This rate should be estimated by the examiner from the total number of days in operation and total amount of wages paid, and should be the average daily earnings for the period that they are employed.

The "Total amount paid for such work" should agree with the amount reported as paid to miners and miners' helpers under Inquiry 3, and this amount should include the amount reported as paid for yardage or other allowances. As reported on this schedule, these allowances are frequently not included in the amount paid for mining. This may be verified by calculating the amount that would be received on the product reported, under Inquiry 9, at the rate given under Inquiry 4, and if it is found that the amount is not included it should be added, the correction being made in red ink.

Inquiry 6—Contract work.—Care should be taken that the information given under this inquiry is not duplicated under Inquiries 3 and 4. It is probable that in only a small proportion of the schedules will information be given under this question, but, when reported, it should be treated as separate information not included under any of the other inquiries. In calculating the expense of operating the mine for the purpose of comparison with the value of the product, the amount reported as paid for contract work should be added to the other expenses for wages, supplies and materials, and miscellaneous expenses. When an amount is reported as paid, the "Average number of men employed" and the "Number of days" should also be reported.

Inquiry 8—Royalty and rent of mine.—In examining this inquiry, reference should also be made to Inquiry 16, and if any rate is given, an amount should be reported under Inquiry 8 as paid for royalties. This amount need not necessarily be the amount obtained from calculating the royalty on the number of tons reported mined under Inquiry 9, by the rate given under Inquiry 16. It can in no case be more, but may be less. Royalty is frequently paid on only a part of the product of the mine. It should be borne in mind that while the product is reported under Inquiry 9 in short tons, royalty is frequently paid in long tons. This is also true of Inquiry 4, the miners being paid for long tons and the product marketed in short tons. The general instructions apply to other features of Inquiry 8.

Inquiry 9—Product.—The data reported under this inquiry should not be inconsistent with information given under the other questions on the schedule. In bituminous coal mining the quantity of coal taken from the mine will agree in most cases with the marketable coal reported. If no information is given as to the number of cars of coal taken from the mine and the average capacity of such cars, the information should be supplied on the basis of the information given in other reports of mines in the same locality.

There will sometimes be a difference shown in the reports of bituminous coal mines between the quantity of coal hoisted and the quantity of marketable coal. In anthracite coal mining, owing to the larger proportion of coal which can not be utilized, the difference between the coal taken from the mine and that marketed will in many cases be considerable, the latter being less than the former. This is the result of the crushing, screening, and cleaning processes by which the coal is prepared for shipment.

Inquiry 10—Power.—In all large mines power in some form should be shown. The purposes for which it is required are for operating the crushing and screening machinery, for hoisting, pumping, and ventilating, and sometimes for other subsidiary purposes. A knowledge of the conditions found at coal mines is generally necessary to properly edit this question. If the opening to a vein is a shaft or slope, a hoisting engine will be required and in all probability one or more pumping engines, and if fan ventilation is employed, an engine will be necessary to operate the fan. Other methods of ventilation do not require the use of power.

Inquiry 11—System of haulage.—The information required under this inquiry is where a mechanical system of haulage has supplanted to some extent the use of animal power, such as horses and mules. It does not apply to the mechanical power used for hoisting coal from a shaft or slope.

Inquiry 12—Slate pickers or coal cleaners.—This inquiry is intended to apply only to anthracite mines. In separating the slate from the coal mechanical means have been substituted to a very large extent for boys, and the object of the inquiry is to determine the magnitude of this change or improvement in anthracite mining.

Inquiry 13—Washeries.—This question also is intended to apply only to anthracite coal mines. The use of washeries for cleaning coal, which formerly was allowed to lie on waste dumps, is comparatively a recent development, and by the use of such washeries a much larger proportion of the coal mined is available for shipment. Wherever a washery is reported under this inquiry there should be a separate report in the files giving the operations of the washery.

Inquiry 14—Openings to the works.—Whenever a shaft, slope, or tunnel is given as the nature of the opening to the vein, its depth or length in feet should be given. This information is not required where the mining is by drift or open cutting or stripping.

Inquiry 16—Coal mined on royalty.—If any rate is reported under this question, corresponding information should also be reported under the first item of Inquiry 8.

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Special attention should be paid to the reports of bituminous coal mines where coke is manufactured. This information will be found on the slip containing the Geological Survey details of production. Only the capital stock, general officers, expenses, etc., pertaining to coal mining should be included in the schedule. If any of these data pertaining to coke manufacture are included, a separation should be made, based on the relative proportions of the two branches of the business.

GOLD, SILVER, LEAD, AND COPPER MINES.

In editing Special Schedules Nos. 10, 10a, 10b, 11, 11a, and 11b, the following instructions are to be followed and applied to the revision of the special features of the schedules, in addition to the application of the general instructions heretofore given to those inquiries which are identical in form in all the census schedules.

I. General Rules.

1. *By whom the report should be made.*

The report should always be made by the party operating the mine; when a mine is leased, one report should be obtained from the lessee and another from the owner, and both schedules should be combined; one should be marked "Owner's report," the other "Lessee's report." The owner should, in such cases, report only his own production and expenditures exclusive of the production of the lessees. An exception from this rule is made in the case of "leasers" or "tributers," of which see further.

In some cases one report is made indiscriminately combining the capitalization and some of the expenses of the owner with those of the lessee. In such cases a segregation should be made at this office; all items pertaining to the owner should be transferred to a separate schedule.

If a mine has changed hands in the course of the year 1902 separate reports are required from each owner or lessee for the time he operated. These reports should be combined, but all repetitions should be eliminated from one of the schedules. (See Inquiries 13, 14, 15, and 16.)

2. *Small and Chinese mines.*

There are a number of schedules marked "Small and Chinese" with nothing but an estimated value of the product. All such schedules should be assorted into a separate group to be tabulated on a separate sheet.

3. *General office.*

The address of the general office must be given on the title page of the Census schedule and also on the United States Geological Survey transfer slip (Schedules Nos. 10a and 10b). Very frequently the address is given on the United States Geological Survey transfer slip alone; in such cases it should likewise be written on the title page of the Census schedule.

If no general office is maintained separately from the mine, write in red ink after the words "general office" the word "mine."

4.—*Preliminary classification.*

All Schedules No. 10 should be classified under one of the following four groups:

First. Productive.

Second. Development work.

Third. Assessment work.

Fourth. Idle.

(1) A productive mine is one which produces ore or metal.

(2) If no ore or bullion is produced or the quantity is out of all proportion to the total amount invested in labor, the mine is classed under the second subdivision (development work).

(3) If a little work is done to comply with the requirements of the law, the mine is classed under the third subdivision (assessment work).

(4) If no work of any description was done during the year 1902, though some ore previously mined may have been shipped, the mine is classed under subdivision 4 as "idle."

In assorting schedules for tabulation those showing only development work without any production whatsoever must be segregated from those where production is reported as incidental to development.

Only schedules of the first and the second class must be edited; those of the third and fourth class require no editing.

All schedules relating to productive mines are to be assorted into two groups, viz, (1) placers and (2) deep mines. In editing the schedules these designations must be written in red ink on the title page of each schedule in the blank space after the words "Character of ore." The character of the mine is to be determined from the annexed Geological Survey schedule attached to Schedule No. 10. A deep mine is reported on Schedule No. 10a, a placer on Schedule No. 10b.

"Deep mines" are further assorted into two groups, *with or without a mill connection.* When a mine has no reduction works, the report is on Schedules Nos. 10 and 10a. Where a mine is connected with a reduction works, there must be Schedules Nos. 10 and 10a, 11 and 11a. These again are to be assorted into two subdivisions: Those where complete reports are furnished for the mine and the mill and those where the mine and reduction works are covered by one combined report, in accordance with the note on the title page of Schedule No. 10.

Placer mines as a rule require no mill; in some cases, however, where the ground is cement, it must be crushed in a stamp mill. In such cases a Schedule No. 11 is attached to Schedule No. 10, as in the case of a deep mine. Such reports must be segregated into a separate group. Reduction works without a mine connection are reported on Schedules Nos. 11 and 11a, except those running on old tailings, of which see further.

II. MINES WITHOUT MILL CONNECTION.

1. *Development work without production.*

Where a report shows only development work without production, Schedule No. 10 alone is to be edited and prepared for tabulation; Schedules Nos. 10a and 10b should be disregarded.

Inquiry 9.—The total value of development work must in such cases be equal to the total amount expended and need not be reported separately. If it is so reported it should be erased. Very frequently the amount reported under this inquiry is equal either to the total wages and salaries or to the total wages alone, or to the sum of wages, salaries, and supplies, or to the sum of wages and supplies, or to the amount paid for contract work. All such answers should be erased. If, however, the amount reported is either in excess or short of any of these quantities, the schedule should be criticised; in the former case it may eventually disclose an omission under Inquiries 4, 7, or 8, or the amount may represent the expenditure of more than one year. Among the schedules of this class a number will be found where nothing but the amount expended in development work is reported; they probably represent merely assessment work on more than one mining claim in each case. All such schedules should be segregated into a separate group.

In many cases the work was done by the owner and his family and the amount reported is an estimate of the value of his labor. Such schedules should likewise be segregated into a separate group. (See further instructions to Inquiry 4.)

If the value of the development work done in such cases is estimated, write in the blank space, after "Amount expended in development work," the words "Done by owners."

In case development work is done in consideration of a lease and the amount is estimated, write similarly, "Done by lessees."

Aside from these instructions all schedules of this class are to be edited in accordance with the general rules applying to the Mining Census.

2. *Productive mines.*

The following instructions apply to all schedules where production is reported, including those where production is incidental to development work:

Inquiry 4.—In case the mine is worked by the owner or operator, with the assistance of members of his family, without hired labor, the fact should be noted as follows: Write in red ink after the words "persons employed," the words "no hired labor," erase the words "general officers" and write "owners working," giving the number, if known, in the first column. The same entry with regard to "owners working" should likewise be made where hired labor is employed, in addition to the owner's labor. By "owner" is meant the party in actual possession of the mine, whether as owner or lessee. The words "no hired labor" and "owners working" should also be written in red ink on the title page at the upper end of the right margin. All such schedules should be assorted into two separate groups.

Inquiry 5—Lessees.—In case the mine is worked under the so-called "leasing" or "tribute" system, i. e., when it is leased in blocks to a number of miners, each paying a royalty to the owner, no answers are required under Inquiry 4, but a report must be made under Inquiry 5, as follows:

After the words "If mining is paid for by the ton, car, or other unit, give the rate paid and character of unit," write: "Worked by lessees on —— per cent of royalty;" insert the percentage charged by the owner to the lessees, specifying whether "gross" or "net," i. e., whether computed on the gross or on the net product. In the next blank space insert the average number of lessees employed.

After the words "Total amount paid for such work" insert the amount received by the lessees out of the total product after deducting treatment and freight charges and royalties. For example, if the gross product reported under Inquiry 10 is $10,000, the net product is $6,000, the rate of royalty 25 per cent net, then the entry in the first blank space should read as follows: "Worked by lessees on 25 per cent royalty, net," and in the last blank space, "$4,500." If the rate of royalty is varying or is not stated, compute the average net rate. For this purpose first obtain the amount of the royalty by subtracting the amount received by the lessees from the total net value of the mining product, and next compute the percentage of royalty to the total net value. In many cases the rate of royalty reported represents the percentage of the lessee's share to the total product; this is an error. If the value of the product is $6,000 and the lessees received $4,500, the rate of royalty is not 75 per cent but 25 per cent, the ratio of the royalty, $1,500, to the total product. If any estimates of wages received by lessees are given under Inquiry 4, they should be erased by drawing red lines through them.

On all such schedules write on the title page in the right margin after the words "Name of the company, etc.," the words "Block lessees." For the sake of uniformity this term should likewise be used in the few cases of placer mines worked on the tribute system, but the words should be in quotation marks.

Mines worked on shares.—If the mine is worked on shares no answer is required to Inquiry 4, but the report under Inquiry 5 must read, "Worked on shares." the number of men so employed should be given in the next blank space.

Inquiry 8.—The answer to this inquiry must not include any expenditures of a permanent nature which has no direct relation to the mine, such as construction of buildings, mills, dwelling houses, etc. If any such expenditure is included, a request for correction should be made, asking that the expense be eliminated. If no answer is made to this inquiry, write the word "None." In some cases the cost of supplies and materials is reported to include also "Miscellaneous expenses," which ought to be reported under Inquiry 9. No segregation should be attempted, but after the words "Miscellaneous expenses" write in red ink "See Inquiry 8."

Inquiry 9—Development work.—The amount reported under this inquiry is, with very few exceptions, also included under Inquiries 4, 7, and 8. In the absence of indications to the contrary, this fact should be noted in red ink, a line should be drawn under the amount expended in development work, and the entire entry should be included in brackets. The amount should not be added with the other items reported under this inquiry, and if it is so added it should be eliminated from the total.

If it appears that the amount reported for development work is not included in the operating expenses, information should be obtained by communicating with the operator for the purpose of apportioning the expenditure under Inquiries 4, 7, and 8. If it is not possible, a note should be made in red ink "Not included in operating expenses." If the amount reported for development work is equal to the total wages and salaries, or total wages alone, or to wages, salaries, and supplies, or wages and supplies, or any of these items in connection with contract work, the item should be erased.

If, however, the amount of development work is equal to the amount paid for contract work alone it should stand.

Expenditures for construction of mills should not be included under "Development work," and the amount so included, if any should be eliminated.

Rent and royalties.—Whenever it appears from the answer to Inquiry 12 that land is held on lease, some rent or royalty should, as a rule, be reported under Inquiry 9. In some cases, however, the consideration for the lease is a certain amount of development work, so that if the report shows an expenditure for the same, but no rent or royalties, the answer may be deemed consistent.

Payments on "bond and lease" are in the nature of payments on a purchase-money mortgage and should be eliminated.

If the answer to Inquiry 15e shows that power was supplied to the mine by another establishment, the rent paid for power should be reported either under "Water rent," or, in case any other power was supplied, under "Other rent or royalties."

If water rent or rent of electric power is included among "Supplies and materials" (Inquiry 8), or in the last item of Inquiry 9 (amount paid for taxes, insurance, etc.), it should be eliminated. If the report does not conform with these requirements, a request for correction must be sent.

Amount paid for taxes, insurance, etc.—If the cost of supplies and materials is included in this item and no report is made under Inquiry 8, the amount so reported should be transferred to Inquiry 8, and a note in red ink should be made reading, "See Inquiry 8."

Total.—The total should always be inserted, even if there is only one item; such item should then be restated as the "Total."

III. PRODUCT.

The product is reported on Schedules Nos. 10a and 10b, as the case may be, and on Schedule No. 10, Inquiry 10.

A. PLACER MINES.

Schedule No. 10b—Inquiry 3.—It is intended that the report should give (a) the exact crude weight of the gold product, the total gross value allowed for it by the mint or private party buying the same, and (b) the average fineness of the gold produced. The crude weight multiplied by the average fineness will furnish the total number of fine ounces. (bb) There are very few schedules, however, where this inquiry has been properly answered. In many cases the value alone is given in round figures, which is usually an estimate; sometimes the average fineness is given with it. In such cases a request for correction should be sent, asking the number of crude ounces. In other cases the price paid per crude ounce is given. The number of crude ounces can be obtained by dividing the value by the price per ounce. In such cases the schedule should be criticised with a view to ascertaining the average fineness. In some cases the average fineness reported represents the ratio between the price per crude ounce and the coining value of a fine ounce, viz, $20.67. This is incorrect, as the price paid per ounce is always less than the coining value of the gold; such "fineness" should be disregarded.

In those cases where a complete report is made and the value of the product appears to be less than the coining value, i. e., than the number of fine ounces multiplied by $20.67, the coining value should be substituted for the value reported in answer to Inquiry 3 on Schedule No. 10b as "Gross value," while the amount reported should be erased from Schedule No. 10a and transferred to Schedule No. 10, Inquiry 10, as "Net value of the mining product."

If the number of crude ounces is given and the amount is figured at $20 per ounce, the ounces should be taken as fine and entered on Schedule No. 10b at *bb*. The value should appear on Schedule No. 10, Inquiry 10, both as *gross* and *net*.

If no reliable data showing the number of fine ounces are available, Inquiry 3bb should be left blank. All such schedules should be assorted into a separate group for tabulation.

Schedule No. 10—Inquiry 10.—The gross value of the metallic contents must be equal to the total reported on Schedule No. 10b under Inquiry 5. The "Charges for treatment" should include mint charges, commissions, etc.; the "Freight" represents expressage and insurance on bullion. These questions, however, are hardly ever answered.

The "Net value of the mining product" is usually reported equal to the "Gross value," which is incorrect. Whenever the actual gross value can be obtained, as explained above, the difference between the gross value and the net value will represent the charges for treatment and should be so entered.

In most cases either the gross or the net value alone is reported under Inquiry 10, Schedule No. 10. If this missing item can not be obtained, the amount reported on Schedule No. 10a should be entered on Schedule No. 10 as "Net value of the mining product."

B. DEEP MINES.

Schedule No. 10a—Inquiries 1, 2, and 3.—There should be a complete answer to these three inquiries. If the total quantity of ore mined in 1902 exceeds the total quantity sold or treated during the same year, then the stock on hand December 31, 1902, should exceed by the same quantity the stock on hand December 31, 1901. Conversely, if the quantity sold or treated exceeds the quantity mined there must be a corresponding decrease of the stock on hand.

If the quantity sold or treated is reported the same as the quantity mined, the stock on hand on both dates must be the same.

Very often the stock on hand is not reported at all. In case the quantity sold or treated is the same as the quantity mined, the omission may be disregarded. In case those quantities are not the same, the increase or decrease, as the case may be, should be entered on the reverse side of Schedule No. 10a under Inquiry 12. In order that the total net increase or decrease of the stock of ore on hand should agree with the total stock on hand December 31, 1901, and December 31, 1902, the increase of stock should also be entered under Inquiry 3 as "stock of ore on hand December 31, 1902," while the decrease should be entered under the same inquiry as "stock of ore on hand December 31, 1901."

Inquiry 4—Bullion contents of the ore.—The answer to this inquiry specifies each metal contained in the ore. Enter the name or names of the metals on Schedule No. 10 in the upper corner of the title page, viz, "Gold," or "Silver," or "Copper," or "Lead," or "Gold and silver," or "Silver and lead," or "Gold, silver, and lead," or "Gold, silver, and copper," etc., as the case may be. All schedules have heretofore been marked "Gold and silver;" this designation should be allowed to stand only when it corresponds with the actual contents of the ore, otherwise it should be corrected as above indicated.

Quantity.—Gold and silver must be given in fine ounces, copper and lead in pounds.

If iron, zinc, or manganese is contained in the ore, the quantity must be reported, even though no allowance may have been made for it in the value of the ore.

In some cases the answer, instead of giving the total quantity of each metal contained in the product reported, states only the contents per ton. In such cases the contents so reported should be multiplied by the number of tons sold or treated and the totals inserted where they belong.

Base metals are sometimes given in percentages. In such cases the quantity can easily be computed. Usually in adjusting the price of the ore a discount or allowance is made for losses in smelting; as a result, in many cases the quantity reported is the net quantity for which payment was received, instead of the total contents of the ore as shown by assay. This is incorrect, and wherever the fact is disclosed the schedule should be corrected by inserting the actual contents of the ore instead of those for which payment was received. If the actual contents can not be calculated, a request for correction should be addressed to the operator. The value of the product should, however, not be changed.

Value.—The value of each metal ought to be reported by the operator. It should in every case be the value actually allowed to him by the smelter or ore buyer. Only where it is impossible to obtain a report from the operator should the averages of the United States Geological Survey be accepted as substitutes.

The United States Geological Survey, in its tabulation, discards the values reported by the operators and substitutes, in lieu of them, uniform average prices, viz, $20.67 per ounce of gold fine, $0.52 per ounce of silver, $0.11 per pound of copper, and $0.04 per pound of lead.

These averages represent the coining value of refined gold and the annual average New York quotation of all other metals. While the New York quotation of silver is often taken as a basis of settlement for ores, yet there are few schedules, if any, where the value reported by the operator for copper and lead approximates the New York quotation. Copper is usually reported at 5 and 6 cents per pound, instead of 11 cents, as accepted by the United States Geological Survey. Lead is usually reported at 1½ to 2 cents per pound instead of 4 cents. Some of the largest buyers in the United States allow a uniform price of 3½ cents per pound from which 2 cents per pound are deducted for freight from Salt Lake City to New York. Thus actually the net price paid is 1½ cents per pound.

Whenever the average value per ounce of gold is less than $19 the presumption is that the ounces are not fine, but crude; in such case the schedule should be criticised.

The price for silver in 1902 was subject to considerable fluctuations; the highest price did not exceed 56 cents. If the price reported by the operator is in excess of this rate, the schedule should be criticised.

Value alone reported.—When the values alone of the bullion contents are reported but not the quantities, a request for correction should be made. If it is impossible to obtain these data directly from the operator, the quantity should be estimated at this office. In such cases Schedule No. 10, Inquiry 11, should be consulted. If the address of the reduction works is given to which the ore was sold, the rate at which each metal was paid for should be obtained from the report of the respective mill or smelter. If such information is not available, then the quantities should be estimated on the basis of the United States Geological Survey averages.

Schedule No. 10, Inquiry 10—Gross value of the metallic contents as reported to the United States Geological Survey.—This value should be equal to the total value on Schedule No. 10a.

DEDUCTIONS.

The deductions consist of the following items:

Discounts.—As has been explained above, very frequently a discount is made for losses in smelting. Thus the price per ounce of gold is made $20, but 5 per cent is deducted as a discount, bringing the actual price down to $19. Some operators will report the value of gold at $20 and charge off a corresponding amount under "Discounts." Similarly, some will report discounts on silver and lead. Whenever such discounts are reported separately, they should be preserved under "Deductions," to be subsequently tabulated.

Very frequently only one amount is reported for discounts. No segregation of the discounts need be made in such cases.

Charges for treatment.—This item ought to include charges for sampling, assaying, and milling or smelting. If these several charges are reported separately, they should be combined into one item. *In such cases a memorandum giving the name of the mine and mining company, the state and county, should be made and delivered to the expert special agent in charge.* Usually the treatment charges include also discounts. If the latter are not reported separately no segregation should be attempted, but the amount should stand as reported.

In some cases the treatment charges include freight charges. The amount reported should be allowed to stand; no segregation need be made.

Freight charges.—These include the cost of packing and haulage by team and railroad freight.

When the two items are reported separately, they should be allowed to stand.

Charges and freight per ton.—Besides the total charges, the inquiry calls also for charges and freight per ton. The latter can be given only when every shipment of ore was treated at one establishment.

It frequently happens, however, that the ore is first concentrated at a custom mill and the concentrates are then shipped to a smelter. The tonnage shipped to the mill is then quite different from that shipped to the smelter; average rates per ton would in such cases be misleading and should be erased. *All such schedules should be referred to the expert special agent in charge.*

No charges.—In many cases the full value of the gold and silver contents of the ore is paid to the operator, no charges whatever being made for treatment and freight; this is when the ore contains a high percentage of iron and manganese, which are not paid for. Sometimes the percentages of iron and manganese are so high that a bonus is paid to the mine operator, besides free treatment and freight. The amount of the bonus should be entered on Schedule No. 10a, Inquiry 4, as the value of the iron or manganese.

NET VALUE OF THE MINING PRODUCT.

The net value of the mining product is equal to the gross value less the deduction for treatment charges and freight.

In some cases the question was misunderstood, and the net profits were reported instead of the net value of the product. The amount should be properly corrected.

In many cases nothing but the net value of the mining product is reported by the operator; it is when the ore was sold "at a flat price per ton." In such cases, if the metallic contents are reported on Schedule No. 10a, Inquiry 4, the total value, as calculated by the United States Geological Survey, should be accepted as the "gross value," the net amount received by the operator as the "net value," and the difference should be entered under "Deductions."

HIGH-GRADE AND LOW-GRADE ORES.

Schedule No. 10a, Inquiry 11.—Divide the total contents of gold and silver given under Inquiry 4 by the total quantity given under Inquiry 2; enter the results under gold and silver. Compute in the same manner the number of pounds of copper, lead, and other metals per ton, and, further, divide each quotient by the number 20, which will give the percentage of copper, lead, etc.; enter the same in the proper places.

Divide the total value given under Inquiry 4 by the amount of ore sold or treated given under Inquiry 2. Enter the result under "aggregate gross value."

If the "aggregate gross value" is less than $10, it is "low-grade ore," if more than $10, it is "high grade." The designations "high grade" or "low grade," as the case may be, must be written on the title page of Schedule No. 10 in the blank space after "character of ore."

INCREASE OR DECREASE OF THE STOCK OF ORE.

Schedule No. 10a, Inquiry 12.—Deduct the stock on hand December 31, 1901, from that of December 31, 1902, or vice versa, and enter the difference under increase or decrease.

Divide the "net value of the mining product," given on Schedule No. 10, Inquiry 10, by the number of tons sold or treated and multiply the difference by the increase or decrease of the stock of ore on hand.

TOTAL ESTIMATED VALUE OF THE MINING PRODUCT.

Schedule No. 10a, Inquiry 13.—Add the estimated value of the increase of stock, entered under Inquiry 12, to the net value of the mining product, as given under Inquiry 10 on Schedule No. 10, or deduct the estimated value of the decrease of stock from the net value of the mining product. Enter the result as the "total estimated value of the mining product."

IV. Name and Address of Mill or Works at which the Ore is Treated.

Schedule No. 10, Inquiry 11.—The answer to this inquiry should indicate the disposition made of the ore, whether it was *sold*, or *treated at the company's reduction works, or treated at a custom mill.* When the ore is treated for the account of the mine operator at a mill directly connected with the mine, the fact should be stated: if not stated, it will appear from the accompanying Schedule No. 11, and the answer should be supplied at this office in terms identical with the underlined phrases above.

If the address of a mill or smelter is given, but the report fails to state whether the ore was sold or treated on tolls, the character of the mill should be ascertained by references to the schedule whereon it is reported. If it proves to be one which both buys ores and treats them for the customer's account, the answer to Inquiry 4, on Schedule No. 10a, will ordinarily be reported in crude ounces, which will appear from the low valuation of the gold. *In cases of uncertainty the schedule should be referred to the expert special agent.*

V. Process of Treatment.

Schedule No. 10, Inquiry 11; Schedule No. 10a, Inquiries 8 and 10.—All ores are classified according to process of treatment into *milling* and *smelting ores.* The process of treatment will appear from the answers to Inquiries 8 and 10, on Schedule No. 10a, or Inquiry 11, on Schedule No. 10.

If the ore is concentrated and then smelted, it should be classed as a milling ore.

The designation "milling" or "smelting" should be written on the title-page of Schedule No. 10, in the line reserved for "character of ore."

Arrastra of mine.—No Schedule No. 11 is required for "arrastras," but all reports for mines connected with arrastras should be segregated into a separate group.

Reduction of ores by hand.—In a number of small mines the ore is reduced by hand in a mortar. All reports for such mines should be assorted into a separate group.

VI. Mineral Lands.

If the dimensions of the claim are reported instead of the acreage, the latter should be computed. If the number of mineral claims is reported, the acreage should likewise be computed by multiplying the number of claims by the average size of the claim as determined by law. If the report shows no land owned and some held on lease, a note should be made on the title-page, in the upper right-hand margin, reading "lessee's report."

VII. Reduction Works.

Reduction works have been divided for census purposes into *smelters* and *reduction works other than smelters*, or mills, the former being reported on Schedule No. 12, the latter on Schedule No. 11 and 11a or 11b.

All smelter reports must be referred to the expert special agent in charge. In some cases smelters were erroneously reported on Schedule No. 11. Such schedules should likewise be referred to the expert special agent, together with all Schedules No. 10 relating to mines connected with smelters.

All mills are to be divided for tabulation purposes into two classes, (1) mills without mine connection, commonly designated as "custom mills," and (2) mills connected with mines.

A. CUSTOM MILLS.

Reduction works, other than smelters, without a mine connection are reported on Schedules No. 11 and No. 11b.

Inquiries 1, 2, 3, 7, and 11 are substantially identical with Inquiries 1, 3, 6, 8, and 15, respectively, on Schedule No. 10. (See instructions above.)

Inquiry 4 on Schedule No. 11 corresponds to Inquiry 4 on Schedule No. 10, except that the division "below ground" is absent.

Inquiry 8 on Schedule No. 11 corresponds to Inquiry 9 on Schedule No. 10, with the omission of "development work," and of the detailed inquiry into rent or royalties.

Inquiry 12 serves the same purpose as Inquiry 11 on Schedule No. 10.

Inquiry 6—Materials bought in 1902.—This inquiry is in form a combination of Inquiry 4 on Schedule No. 10a and Inquiry 10 on Schedule No. 10, and is intended to bring out the same information, but from the standpoint of the mill owner. (See instructions above.)

Nothing but materials bought should be reported under this inquiry. The values to be reported under this inquiry are those contained in the ore before treatment and are not identical with the values extracted, which are reported on Schedule No. 11a; with the best methods known a portion of the contents is lost in the residue, or "tailings." If, therefore, the assay contents reported appear to be identical with the final product reported, a request for correction should be made.

The "working charges" are those made by the owner of the reduction works on the ore bought by him, and not those deducted from the value of his bullion or concentrates by the mint, smelter, or sampler buying the same. The charges on the final mill product must be reported under Inquiries 5 or 9. In case the answer to Inquiry 6 duplicates in this particular the answer to Inquiry 5 or Inquiry 9, a request for correction should be made. Nor are these charges identical with those under Inquiry 10, which relate to "custom work," i. e., to the treatment of ores for patrons' account, and not to ores bought by the mill.

PRODUCT.

The gross value of the mill product is reported on Schedule No. 11b, under the head of "Production," and transferred therefrom to

Inquiry 9 on Schedule No. 11, as "gross value of metallic contents as reported to the Geological Survey." The inquiry is so worded as to include both the product of *purchased ores* and of those *treated for customers' account.* In actual practice, however, few mills reported the product of custom ores, stating that the bullion or concentrates were returned to owners and no record thereof was kept at the works, except the tonnage treated and the amount received for treatment. In those few cases where the contents of custom ores are given they are confessedly more or less loose estimates, with hardly any exceptions. For the sake of uniformity of results nothing but the product of purchased ores should be allowed to stand under the head of production.

In case no ores were purchased the fact will appear from the answer to Inquiry 6 on Schedule No. 11. In all such cases the total quantity under "Production" on Schedule No. 11b must be identical with that reported under Inquiry 10 on Schedule No. 11. The "total yield in gold," "total yield in silver," copper, lead, and other metals, if reported, should be crossed out and the word "None" should be inserted; likewise should the word "None" be inserted under Inquiry 9 on Schedule No. 11. But the same amounts under "sources of materials treated" should not be disturbed.

In case the mill handled both purchased and custom ores, a comparison of Inquiries 6, 9, and 10 on Schedule No. 11, and "production" and "sources of materials treated" on Schedule No. 11a will assist in determining the product of purchased ores alone. In case of uncertainty a request for correction should be sent.

For particulars in relation to the several items of the yield from purchased ores (gold, silver, lead, copper, etc.), see instruction above for mining product.

Treatment and freight charges.—The milling product requires further treatment at a mint, refinery, or smelter. Usually the product is sold, sometimes it is treated on tolls for the account of the mill owner. In the former case the deductions from the gross value of the product should be reported under Inquiry 9, in the latter case under Inquiry 5.

Sometimes the same amounts are duplicated under Inquiries 5 and 9. In such cases it may be safely assumed that the product was sold, and the answer to Inquiry 5 should be erased. When no purchased ores were treated at the mill, the answer to Inquiries 5 and 9 should be "None." For further particulars see above instructions for "Mines."

CUSTOM WORK.

Schedule No. 11, Inquiry 10.—The "amount received" should represent the mill charges for the work of the mill, not the value realized by the customer from the sale of his bullion.

Sources of material treated—Schedule No. 11b.—In a very few schedules this inquiry has been answered. The answer should be supplied at this office. Transfer the tonnage and values given under "Productions" to Inquiry B, on the reverse side of Schedule No. 11b, entering the same under "Total domestic."

If the inquiry is answered, transfer likewise the values to Inquiry B, entering them under "Total domestic" or "Total foreign," as the case may be; for the tonnage repeat that given under "Production."

Schedule No. 11b, Inquiry A—Bullion contents, assay contents before treatment, and average value per ton of product from purchased materials.—Divide the amounts given under "Production" by the quantity of ore treated given under the same inquiry; further divide the quotients for the base metals by the number 20; enter the results in the first column.

Divide the "gross value of the metallic contents, etc.," given on Schedule No. 11, under Inquiry 9, by the same quantity of ore, as above, and enter in the space below for "average value per ton."

Divide likewise the assay contents and total gross value of all materials reported on Schedule No. 11, under Inquiry 6, and enter the results in the second column.

B. MINES CONNECTED WITH REDUCTION WORKS.

In accordance with the classification of reduction works into "smelters" and "other than smelters" (mills), mines will be found connected with smelters or mills.

The number of mines connected with smelters is very limited. The reports for such mines should be attached to the smelter reports and referred to the expert special agent for separate treatment.

Where a mine and reduction works are operated under the same management, separate reports were requested for each on Schedules Nos. 10 and 11. But where this was not possible (because the accounts for the mine and the mill were not kept separately) one report was requested covering both the mine and mill. Inquiries on Schedule No. 10 were to be answered, except Inquiry 10, and answers were also to be given to Inquiries 4, 5, 9, 10, and 12 on Schedule No. 11.

Most of the schedules which have been received report both the mine and the mill together; there are, however, a considerable number of schedules where the mine and mill are reported separately; a further number of separate schedules for reduction works have been prepared at this office from printed annual reports furnished by the mining companies. Accordingly, all schedules should be assorted into two classes: (1) Those where the mine and the reduction works are reported separately, (2) those where they are reported together.

1. *Separate reports from mine and mill.*

In examining the former, the instructions should be followed which have been laid down for separate mine and mill reports, except that Inquiries 1 and 2 on Schedule No. 11 should be left blank.

Similar to these reports are those where *all inquiries relating to the mine and reduction works are answered separately, except those relating to production, viz,* Inquiry 10 on Schedule No. 10 and Inquiry 9 on Schedule No. 11, which are duplicated. The answer to Inquiry 10 on Schedule No. 10 should in such cases be crossed out.

Hauling from mine to mill.—If the mill is at a considerable distance from the mine, the cost of hauling the ore from the mine to the mill is very frequently reported on Schedule No. 10 under Inquiry 10. In all such cases this item should be allowed to stand, and should not be transferred to Inquiry 9 on Schedule No. 11.

Power.—In some cases Inquiry 11 on Schedule No. 11 is answered. It must be ascertained whether it contains no duplication of the power reported on Schedule No. 10. If there is no duplication, the answer should be allowed to stand.

2. *One report for both mine and mill.*

Where only one report is made for the mine and reduction works, all instructions relating to each schedule should be followed as far as applicable.

Mill supplies.—Where one report only is made for the mine and the mill, Inquiry 7 on *Schedule No. 11* is sometimes answered. In such cases the cost of mill supplies so reported should be transferred to Inquiry 8 on Schedule No. 10.

Schedules Nos. 10a and 11a.—If the mill is confined to the treatment of the product of the mine, the report on Schedule No. 11a will be a duplication of that on Schedule No. 10a. The former shall, in all such cases, be crossed out, with a note reading "See Schedule No. 10a."

Concentrates.—If the process of treatment includes concentration, the number of tons of concentrates produced should be entered on Schedule No. 11a, in the blank space reserved for "total quantity of products other than bullion." The word "concentrates" should be inserted in red ink.

3. *Milling and smelting ores.*

It is a common practice to assort the ores into "first class" ores, which are shipped to the smelter, and low-grade ores, which will not stand the expense of transportation and must be treated at the mine. In such cases the product should be reported as follows:

Schedule No. 10a, Inquiry 2.—The "total quantity of ore sold or treated in 1902" must be divided into "ore sold" and "ore treated" and each quantity stated separately on the right margin.

Inquiry 4.—The answer to this inquiry should give nothing but the ore *sold;* the words "or treated" should be erased.

Schedule No. 11a.—The bullion contents of the ore treated at the mill must be reported on this schedule. The quantity of concentrates, if any, should be reported in the manner explained above.

Schedule No. 10, Inquiry 10.—The gross value, deductions, and net value of the mining product under this inquiry should be confined to the product sold. A note should be made in each case, reading "see also Schedule No. 11, Inquiry 9."

Schedule No. 11, Inquiry 9.—The gross value, deductions, and net value of milling product under this inquiry should be confined to the product treated at the mill.

All such schedules must be segregated into a separate group

4. *Calculations.*

The answers to the following inquiries on the back of Schedule No. 11a must be supplied at this office:

Inquiry 1.—Bullion contents and gross value per ton of ore mined and milled.

If the bullion is all from ores mined by the same company, divide the bullion contents of the precious metals, given on Schedule No. 10a under Inquiry 4, by the total amount of ore treated, given on Schedule No. 10a under Inquiry 2; the result will give the number of fine ounces of gold and silver per ton. Divide the total copper, lead, and other base metallic contents by the same tonnage treated, and further divide the result by 20; the quotients will give the percentages of lead, copper, etc., in the ore. Divide the total value given under the same head by the same tonnage; enter the quotient under aggregate gross value.

Inquiry 2.—If the bullion is partly from ore mined by the company, partly from purchased ores, the quantities and values given on Schedule No. 11a must exceed those on Schedule No. 10a under Inquiry 4. Deduct the latter from the former; enter the differences in the first and third columns, respectively.

Divide the amounts entered in the first column by the total tonnage reported on Schedule No. 11a under Inquiry 6; divide further the figures for base metals by the number 20; enter the results in the second column.

Divide the total gross value of the third column by the same tonnage and enter in the same column on the line intended for "average per ton."

Similarly, divide the "total assay contents" and "total gross value" reported on Schedule No. 11 under Inquiry 6 and enter the results in the fourth column.

Inquiry 6.—Copy the items entered on the face of this schedule under "Sources of materials treated in 1902." Add separately all domestic and all foreign material and enter the totals on this schedule.

All schedules reporting foreign ores treated must be brought to the attention of the expert special agent.

5. *Placers with stamp mills.*

As a rule, only the product of deep mines requires further treatment at reduction works. The product of placer mines is gold dust or amalgam, which can be sold to a United States mint or assay office, or to a private refinery. In some cases, however, the placer ground is cement, which must be crushed in order to wash out the gold. This is done in a stamp mill. Accordingly, there are a few reports on placer mines with reduction works. These should also be segregated into a separate group.

6. *Old mine dumps and old mill tailings.*

A separate class is formed by those mills which treat low grade ore from old mine dumps or old mill tailings, which could not be profitably treated with the old methods. In every case of this kind the report on Schedule No. 11 and 11b should be supplemented by one on Schedule No. 10, giving the rent or royalties under Inquiry 10. These supplemental schedules must be prepared at this office. Where the method of treatment is concentration, a Schedule No. 11a should also be prepared in the manner indicated on a subsequent page.

The reports for old dumps and old tailings should be assorted into two separate groups.

INSTRUCTIONS FOR VERIFYING AND CORRECTING THE LABOR AND WAGE INQUIRY ON THE MINING SCHEDULE.

As a general rule, the amount of wages and the specified daily rates reported should be accepted as correct. The main object of the revision of this inquiry should be to harmonize the average number of wage-earners, as returned in the several classes under No. 3, employed during the year and the average number of wage-earners at specified daily rates of pay with the amounts reported for each class of employees, the rates of pay, and the time employed.

In revising the number of wage-earners of the several classes the following rules should be followed:

Multiply separately the minimum and maximum of each daily rate under which employees are reported by the number of employees; then multiply each product obtained by the number of days in operation. The results will show the lowest and the highest amounts that could be received as wages. The results obtained by this calculation should be compared with the amount of wages reported for each class of employees under the first section of the inquiry.

If the computation shows that the amount of wages reported for the different classes is within the maximum and minimum, the number of each class of employees should be considered as the correct average number for the time in operation.

If the schedule is properly filled out, the minimum amount (as derived from the above computations) can not be more, nor the maximum amount less, than the actual amount of wages as reported in the first section of the inquiry. Frequent exceptions to this will be found in the class of engineers, firemen, machinists, etc. These employees usually work full time, and there should be no revision of the average number if the amount of wages reported is equal to the amount obtained by the computations of the minimum daily rates multiplied by 300 days. If the amount of wages reported is less than the result obtained by this computation, the revision should be made in the usual manner.

The average number of miners, quarrymen, boys, and all other classes of wage-earners, however, should in all cases be revised to agree with the daily rates and the number of days in operation, giving due consideration, of course, to the fact that certain classes of employees, as a rule, work a larger number of days than others, particularly if the mine does not work the entire number of days in the year.

In reducing the average number of each class of workmen to the average by the year, the basis on which the reduction should be made is the number of days in operation. *Having ascertained the average number of each class of workmen for the number of days in operation, this number should be reduced in the proportion that the number of days in operation is of the entire number of working days in the year, which should be considered as 300.* The following is an example: Number of quarrymen and stonecutters reported, 6, which is the average for the number of days in operation, 250: $\frac{250}{300} \times 6 = 5$, which is the average of employees for the entire year. Should there be any fractional remainder, the following will serve as an example of the method of revision: Number of miners reported

98, which is the average for the number of days in operation, 178: $\frac{178}{300} \times 98 = 58.14$, or cutting off the second decimal place, 58.1. In all cases where the average number of wage-earners is less than one, the fraction should be preceded by a cipher, as for instance, "0.9."

Both in the first and second sections of the wage inquiry the average number of wage-earners should be carried out to one decimal place and the corrected figures entered plainly on the schedule in red ink, the old figures being crossed out. This reduction should not be made in the salaried employees.

Where the minimum wages is greater than the actual wages paid, the average number should be reduced to the number that would earn the wages given at the minimum rate; or, should the maximum wages be less than the actual wages paid, the average number should be increased to the number that would earn the wages given at the maximum rate.

In reducing or increasing the number of hands in the second section of the inquiry, specified daily rates, the number to be deducted or added should be taken from the different daily rates, in the same proportion as the original number at each rate is to the total number of the class under consideration.

Another question that should be considered in this connection is the average number of wage-earners employed during each month. As the schedules are originally reported, the number of each class under the first section of the inquiry is usually the actual number employed while the mine was in operation. The average number of all classes of wage-earners for census purposes is the result obtained by dividing the total of the numbers reported for each month by 12.

An apparent contradiction will sometimes be noted between the number of days in operation and the third section of the wage inquiry, showing the average number employed during each month. For example, the full number of employees may be reported for 12 months, while the number of days in operation may be 250. This may be explained by the fact that the idle days were distributed throughout the 12 months, and in such cases the number of days should be accepted as correct, if consistent with the average number of wage-earners and the amount paid.

If the number of days in operation is in excess of the working days in the number of months reported in the third section, the number of months should be revised to equal as nearly as possible the days in operation. For example, the number of months may have been reported as 7, or 175 days, while the number of days is reported as 240. In this case the number of months should be increased to 9, or 225 days at 25 days per month.

Having revised and corrected the average number of wage-earners in the first and second sections of the inquiry, the average number reported each month should be added and the total divided by 12; if the result is different from the total average number of wage-earners, as revised, in the first and second sections, it should be made to agree by changing the average number for each month in the proportion that each is of the total.

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